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PROCEEDINGS

OF

THE CHEMICAL SOCIETY.

Vol. VIII. Nos. 105—117.
JANUARY—DECEMBER, 1892.

EDITED BY THE SECRETARIES.

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DATES OF ISSUE OF THE MONTHLY NUMBERS OF THE JOURNAL OF THE CHEMICAL SOCIETY TO FELLOWS.

January number was issued		12th January.
February	,,	11th February.
March	,,	15th March.
April	,,	12th April.
May	,,	10th May.
June	,,	1st June.
July	,,	4th July.
August	,,	4th August.
September	,,	1st September.
October	,,	19th October.
November	,,	4th November.
December	,,	10th December.

LIST OF GRANTS MADE FROM THE RESEARCH FUND DURING THE YEAR.

£20 to Mr. A. Hutchinson for experiments on the reduction of benzenoid amides.

£50 to Professor Perkin for continuation of his researches on closed carbon chains.

£5 to Messrs. Linder and Picton for continuation of researches on grades of solution.

£5 to Dr. Laycock for further examination of the products of distillation of bran with lime.

£10 to Dr. Matthews for the continuation of his investigation of benzene hexachlorides and allied compounds.

£10 to Dr. Colman for the study of ε- and δ-amido-fatty acids.

LIST OF FELLOWS ELECTED DURING 1892.

Name.	Proposed.	Elected.
Adams, Arthur	December 17th, 1891	February 18th.
Adams, Frederick Edward	„ 3rd, 1891	„
Adams, Percy Targett	May 5th	June 16th.
Adcock, Samuel Robert	November 17th	December 17th.
Alcock, John W.	April 21st	June 16th.
Anderson, William Smellie	November 17th	December 15th.
Avery, David	„ „	„ „
Ballantyne, Horatio	May 19th	June 16th.
Barratt, Alexander	February 18th	May 5th.
Barrows, Arthur Edward	May 19th	June 16th.
Baylis, Charles	„ 5th	„ „
Bensusan, Arthur John	November 17th	December 15th.
Bleckley, John Sanderson	May 5th	June 16th.
Blyth, Frederick W. George	April 7th	May 5th.
Blyth, Meredith Wynter	February 4th	„ „
Bond, Frederick Fielding	January 21st	February 18th.
Brown, George Fitz	April 7th	May 5th.
Brown, Reginald Busby	February 4th	„ „
Butfield, Horace Vincent	November 17th	December 15th.
Butterfield, Wm. J. Atkinson	January 21st	February 18th.
Campbell, Andrew	November 17th	December 15th.
Carey, Arthur	February 4th	May 5th.
Carlton, Frederick Walter	November 17th	December 15th.
Clark, Ernest Victor	„ „	„ „
Cockerill, Thomas	May 19th	June 16th.
Collins, Hugh Brown	November 19th, 1891	February 18th.
Comyns, Frank	February 18th	May 5th.
Cooper, Arthur James	November 17th	December 15th.
Cooper, Lionel	June 16th	„ „
Couldery, Henry	May 5th	June 16th.
Craig, Andrew C. William	November 17th	December 15th.
Darbyshire, Francis V.	December 17th, 1891	February 18th.
Davies, Joseph	February 18th	May 5th.
Denison, Joseph R.	November 17th	December 15th.
Dodds, George Price	March 3rd	May 5th.
Donaldson, Hudson	„ 17th	„ „
Duffield, Walter William	April 7th	„ „
Duxbury, Thomas	June 2nd	December 15th.
Edwards, Walter N.	April 7th	May 5th.
Ellison, Henry	March 3rd	„ „
Entwistle, Herbert	May 5th	June 16th.
Evans, Sir John	„ 19th	„ „
Floris, Robert Brooke	January 21st	February 18th.
Forster, Martin Onslow	November 17th	December 15th.
Frazer, James C.	February 18th	May 5th.
French, William	November 17th	December 15th.

Name.	Proposed.	Elected.
Gailleton, Alfred Thomas	January 21st	February 18th.
Gibson, John	May 19th	June 16th.
Goodall, Walter	November 17th	December 15th.
Gorgari, Haridas	February 4th	May 5th.
Gray, Thomas	June 2nd	December 15th.
Gronow, William Thomas	,, ,,	,, ,,
Haines, Walter S.	November 17th	December 15th.
Hardy, James G.	,, ,,	,, ,,
Hatton, William Percy	January 21st	February 18th.
Hendrick, James	December 17th, 1891	,, ,,
Hewlett, John C.	,, ,, ,,	,, ,,
Hewitt, John Theodore	February 18th	May 5th.
Hills, Harold F.	April 7th	,, ,,
Hooker, Samuel C.	June 2nd	December 15th.
Horsfall, John	November 17th	,, ,,
Horwell, Edgar E. C.	,, ,,	,, ,,
Humell, Henry Leonard	March 17th	May 5th.
Ince, Walter H.	November 17th	December 15th.
Isaac, John F. V	,, ,,	,, ,,
Jackson, John	November 17th	December 15th.
Jackson, Samuel	June 2nd	,, ,,
Jenkins, John H. B.	April 7th	May 5th.
Johnston, William George	November 17th	December 15th.
Jones, Lionel Manfred	January 21st	February 18th.
Kacker, Kunwar Kishor	November 17th	December 15th.
Knowles, William Torrens	,, ,,	,, ,,
Krause, G.	,, ,,	,, ,,
Lamb, Thornton Charles	November 17th	December 15th.
Lindley, Herbert Edward	March 3rd	May 5th.
Lintern, Albert Augustus	,, ,,	,, ,,
Lloyd, William Howard	November 17th	December 15th.
Luckett, Albert Henry		February 18th.
MacKenzie, William Cossar	January 21st	February 18th.
McFall, John E. Whitley	,, ,,	,, ,,
McKerrow, William James	February 18th	May 5th.
Meacham, Charles Steven	January 21st	February 18th.
Major, George Harry	February 18th	May 5th.
Millar, James Hill	January 21st	February 18th.
Milnes, Ernest E.	February 4th	May 5th.
Mond, Robert Ludwig	January 21st	February 18th.
Moore, Cresacre George	March 17th	May 5th.
Moorwood, Colin Francis	November 17th	December 15th.
Morris, Albert	April 7th	May 5th.
Mulrennan, Joseph Charles	,, ,,	,, ,,
Myers, William Shields	January 21st	February 18th.
Newall, John Fenton	May 5th	June 16th.
Nickolls, John Bate	November 17th	December 15th.
Northing, John	March 3rd	May 5th.
Norris, Charles James	May 5th	June 16th.

Name.	Proposed.	Elected.
Parry, Ernest John	December 17th, 1891	February 18th.
Pullinger, William	" " "	" "
Ramage, Hugh	November 17th	December 15th.
Redman, Henry Ramsden	May 19th	June 16th.
Richardson, Albert Ernest	March 3rd	May 5th.
Richardson, Reginald E. S.	February 18th	" "
Robson, James.	June 16th	December 15th.
Roger, James Wyllie	November 17th	" "
Rothwell, Charles F. Seymour	December 17th, 1891.	February 18th.
Rudolf, Norman Scott	November 17th	December 15th.
Sandercock, Thomas J. B.	December 17th, 1891.	February 18th.
Sarbadhicary, Sadiaprassad	November 17th	December 15th.
Schloessing, Augustus	" "	" "
Schofield, James Alexander	December 17th, 1891	February 18th.
Sell, William James	November 17th	December 15th.
Shaw, George Arthur	" "	" "
Shepherd, Reginald des Forges	" "	" "
Smith, George P. Darnell	December 3rd, 1891.	February 18th.
Smith, Ernest Heber	May 5th	June 16th.
Smith, John Meadows	March 17th	May 5th.
Skurry, Thomas	January 21st	February 18th.
Spackman, Charles	June 2nd	December 15th
Speidel, Ernst	November 17th	" "
Spray, Henry John	December 17th, 1891	February 18th.
Squires, Alfred James	" " "	" "
Stables, William Herbert	April 7th	May 5th.
Stenhouse, James.	March 3rd	" "
Sykes, James	January 21st	February 18th.
Thomson, George de Roos	March 17th	May 5th.
Trewas, Morris William	November 19th, 1891	February 18th.
Trobridge, Arthur	February 4th	May 5th.
Tuer, Arthur Holt	March 17th	May 5th.
Turton, Albert Henry	November 17th	December 15th.
Tweedie, Thomas Shortridge	February 18th	May 5th.
Warren, Cyprian A.	April 7th	May 5th.
Wells, George Isaac J.	February 18th	" "
Westaway, Frederick William	June 2nd	December 15th.
Whalley, Laurence John de	April 7th.	May 5th.
Whiteley, Frederick	" 21st	June 16th.
Whiteside, J. Lowe	November 17th	December 15th.
Wigham, Frederick Henry	" "	" "
Williams, Jno	" "	" "
Williams, William	" "	" "
Willsmore, N. T. N.	" "	" "
Woods, Hugh	" 19th, 1891	February 18th.

FOREIGN MEMBERS ELECTED, JUNE 16TH, 1892.

Fischer, Emil.
Graebe Carl.
Lieben Adolph.
Schiff, Hugo.
Schloesing, Th.

FELLOWS DECEASED SINCE JANUARY 1ST, 1892.

Name.	Born.	Elected.	Died.
Bowler, J. Stephenson........	—	June 21st, 1883.....	November.
Draper, Henry Carter.........	—	February, 21st, 1884.	June.
Heisch, Charles..............	1820	February 23rd, 1841.	January.
Henry, Dr. W. C..............	1804	May 7th, 1853......	,,
Hofmann. Aug. Wilh. von.....	1818	March 3rd, 1849.....	May 5th.
Hooker, John	1834	December 18th, 1862.	April 2nd.
Jackson, J. S................	1850	March 3rd, 1887	October.
Longstaff, Dr. G. D..........	1799	February 23rd, 1841.	September 23rd.
Makins, G. H.................	1815	March 17th, 1845 ...	April.
Merry, J. Saunders...........	—	February 18th, 1875.	April.
Michaels, W. H.	—	December 4th, 1862..	February.
Parnell, E. W................	—	,, 3rd, 1874..	
Redwood, Boverton	1806	November 7th, 1848 .	March 5th.
Schorlemmer, Prof. C.........	1834	December 18th, 1873.	July.
Shilton A. J.	1860	May 5th, 1881	February.
Sieber, C. H.	1825	December 15th, 1881.	June 23rd.
Tate, A. Norman	1837	November 15th, 1860	July.
Taylor, Thomas..............	1814	March 16th, 1846 ...	April 6th.
Tidy, Dr. C. Meymott	1843	December 5th, 1867..	March 15th.
Ward, J. Septibo	—	December 1st, 1887..	November.
Watson, Dr. J. Forbes........	1827	February 4th, 1858..	July 29th.
Williams, Matthew...........	1820	May 18th, 1857	December.
FOREIGN MEMBER.			
Kopp, Hermann	1817	June 18th, 1849.....	February 20th.

TITLES OF PAPERS COMMUNICATED TO THE SOCIETY DURING 1892.

January 21st.

	Page in Proceedings.	Page in Transactions.
1. The estimation of oxygen dissolved in water. By Matthew A. Adams	1	310
2. The luminosity of coal-gas flames. By Vivian B. Lewes	2	322
3. The origin of flame coloration. A preliminary notice. By A. Smithells	8	—
4. Note on the action of dilute nitric acid on coal. By R. J. Friswell	9	—
5. A pure fermentation of mannitol and dulcitol. By Percy F. Frankland, F.R.S., and Wm. Frew	11	254
6. Synthesis of hexahydroterephthalic acid. By J. E. Mackenzie and W. H. Perkin, jun., F.R.S.	12	172
7. The magnetic rotation of dissolved salts. By W. Ostwald	12	—
8. The dissociation of nitrogen peroxide. By W. Ostwald	13	242
9. Corydaline. (I.) By James J. Dobbie, M.A., D.Sc., and Alexander Lauder	13	244
10. Silver compounds of thiourea. By J. Emerson Reynolds, F.R.S.	14	249

February 4th.

	Page in Proceedings.	Page in Transactions.
11. Pedetic motion in relation to colloidal solutions. By William Ramsay, Ph.D., F.R.S.	17	—
12. The acid action of drawing paper of different makes. By W. N. Hartley, F.R.S.	19	—
13. The interactions occurring in flames. A correspondence between Sir G. G. Stokes, Bart., F.R.S., and Henry E. Armstrong	22	—
14. Properties of alcoholic and other solutions of mercuric and other chlorides. By S. Skinner, M.A.	27	339
15. The isomeric α-bromocinnamic acids. By S. Ruhemann, Ph.D., M.A.	28	278

February 18th.

	Page in Proceedings.	Page in Transactions.
16. A search for a cellulose-dissolving (cytohydrolytic) enzyme in the digestive tract of certain grain-feeding animals. By Horace Brown, F.R.S.	30	352

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17. On the influence of oxygen and concentration on fermentation. By Adrian J. Brown	33	369
18. Limettin. By William A. Tilden, D.Sc., F.R.S.	33	344
19. The acid action of drawing papers. By C. Beadle	34	—

March 3rd.

20. A rule for determining whether a given benzene monoderivative shall give a meta-di-derivative or a mixture of ortho- and para-di-derivatives. By Professor Crum Brown and Dr. Gibson	39	367
21. The relative orienting effect of chlorine and bromine. (I.) The constitution of parabrom- and parachloranilinesulphonic acids. By Henry E. Armstrong and J. F. Briggs	40	—
22. Note on anhydrides of sulphonic acids. By Henry E. Armstrong	41	—
23. Contributions to our knowledge of the aconite alkaloids. Part II. The alkaloids of true *Aconitum napellus*. By Professor Dunstan and John C. Umney	42	385
24. Contributions to our knowledge of the aconite alkaloids. Part III. The formation and properties of aconine and its conversion into aconitine. By Professor W. R. Dunstan and Dr. F. W. Passmore	44	395
25. Note on the carbon deposited from coal-gas flames. By Wm. Foster, M.A.	46	—
26. The volumetric estimation of mercury. By Chapman Jones	46	364
27. Chromic acid. By Eleanor Field, Bathurst Student of Newnham College, Cambridge	47	405
28. The origin of acetylene in flames. By Professor V. B. Lewes	47	322

March 17th.

29. A study of the conditions which determine combination between the cyanides of zinc and mercury; and of the composition and properties of the resulting double salt. By Wyndham R. Dunstan	51	666
30. A lecture experiment to illustrate the phenomena of coal-dust explosions. By T. E. Thorpe, F.R.S.	53	414
31. The production of the ketone 1 : 2 : 4-acetylorthoxylene from camphor by the action of sulphuric acid and zinc chloride. By Henry E. Armstrong and F. Stanley Kipping	54	—
32. Platinum tetrachloride. By W. Pullinger, B.A.	54	422
33. Note on a new acid from camphoric acid. By W. H. Perkin, jun., Ph.D., F.R.S.	55	—
34. The specific rotatory and cupric reducing power of invert sugar and of dextrose obtained from cane sugar by means of invertase. By James O'Sullivan	56	408

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35. Ethyldimethylamidobenzene. By W. R. Hodgkinson and Leonhard Limpach	56	420
36. Action of nitric acid on oxanilide and its analogues. By A. G. Perkin	56	458

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Annual General Meeting: President's Address	59	474

April 7th.

1. The separation of arsenic, antimony and tin	68	424
2. Platinous chloride and its use as a source of chlorine. By W. A. Shenstone and C. R. Beck	70	445
3. Note on the adhesion of mercury to glass in the presence of halogens. By W. A. Shenstone	70	452
4. The decomposition of mannitol and dextrose by the *Bacillus ethaceticus.* By Percy F. Frankland, F.R.S., and John S. Lumsden	70	432
5. The preparation of glycollic acid. By H. G. Colman	72	—
6. Researches on silicon compounds and their derivatives. Part VI. The action of silicon tetrachloride on substituted phenylamines. By J. Emerson Reynolds, D.Sc., F.R.S.	73	453
7. Chemistry of the compounds of thiourea and thiocarbimides with aldehyde-ammonia. By Augustus E. Dixon, M.D.	73	509
8. The atomic weight of boron. By J. L. Hoskyns-Abrahall, B.A., Ph.D., late Bishop Berkeley Fellow of the Owens College. (Edited by T. Ewan and P. J. Hartog, of the Owens College)	74	650

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9. Masrite, a new Egyptian mineral, and the possible occurrence of a new element therein. By H. Droop Richmond and Hussein Off	87	491

May 5th.

10. The existence of two acetaldoximes. By Wyndham R. Dunstan and T. S. Dymond. (First notice)	89	470
11. Sulphonic acids derived from anisoils (No. I). By G. T. Moody, D.Sc.	90	—
12. The formation of trithionate by the action of iodine on a mixture of sulphite and thiosulphate. By W. Spring	91	—

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13. The determination of the temperature of steam arising from boiling salt solutions. By J. Sakurai	92	495
14. Note on an observation by Gerlach of the boiling point of solution of Glauber's salt. By J. Sakurai	94	—
15. Chemistry of the thioureas. Part II. (A preliminary note.) By Emil A. Werner	96	—

May 19*th.*

	Page in Proceedings.	Page in Transactions.
16. The magnetic rotation of compounds supposed to contain acetyl or of ketonic origin. By W. H. Perkin, Ph.D., F.R.S.	100	800
17. The origin of colour. II. The constitution of coloured nitro-compounds. By Henry E. Armstrong	101	—
18. The origin of colour. III. Colour as an evidence of isodynamic change: the existence of isodynamic acids. By Henry E. Armstrong	103	—
19. Studies on isomeric change. No. IV. Halogen derivatives of quinone. Part I. By Arthur R. Ling	105	558
20. Halogen derivatives of quinone. Part II. By Arthur R. Ling and Julian L. Baker	106	589
21. The crystalline forms of the sodium derivatives of substituted anilic acids. By William J. Pope	106	581
22. Formation of a hydrocarbon, $C_{18}H_{12}$, from phenylpropionic acid. By F. Stanley Kipping, Ph.D., D.Sc.	107	—
23. Metallic derivatives of acetylene. By R. T. Plimpton, Ph.D.	109	—
24. Isomerism amongst the substituted thioureas. By Augustus E. Dixon, M.D.	111	533
25. Note on diastatic action. By E. R. Moritz and T. A. Glendinning	112	689

June 2*nd.*

	Page in Proceedings.	Page in Transactions.
26. Ethylene derivatives of diazoamido-compounds. By R. Meldola, F.R.S. and F. W. Streatfeild, F.I.C.	119	—
27. The action of light on silver chloride. By H. Brereton Baker, M.A.	120	728
28. The estimation of slag in wrought iron. By A. E. Barrows and Thomas Turner	122	551
29. Corydaline. II. By James J. Dobbie, M.A., D.Sc., and Alexander Lauder	123	605
30. The action of bromine on allylthiocarbimide. By Augustus E. Dixon, M.D.	124	545
31. The hydrolytic functions of yeast. Part I. By James O'Sullivan	124	593
32. The constitution of lapachic acid (lapachol) and its derivatives. By Samuel C. Hooker, Ph.D.	125	611

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33. Contributions to an international system of nomenclature. The nomenclature of cycloids. By Henry E. Armstrong	127	--
34. The production of pyridine derivatives from the lactone of triacetic acid. By N. Collie, Ph.D., and W. S. Myers	131	721
35. The fermentation of arabinose by *Bacillus ethaceticus*. By Percy F. Frankland, F.R.S., and John MacGregor	132	737
36. Resolution of lactic acid into its optically active components. By T. Purdie, Ph.D., B.Sc., and J. Wallace Walker, M.A.	132	765
37. A method for determining the number of NH_2 groups in certain organic bases. By R. Meldola, F.R.S., and E. M. Hawkins	133	—
38. The existence of two acetaldoximes. Second Notice. By Wyndham R. Dunstan and T. S. Dymond	135	—
39. The dissociation constants of organic acids. By James Walker, D.Sc., Ph.D.	137	696
40. Note on the preparation of alkyl iodides. By James Walker, D.Sc., Ph.D.	137	717
41. An examination of the products obtained by the dry distillation of bran with lime. Preliminary communication. By W. F. Laycock, Ph.D., and F. Klingemann, Ph.D.	138	—
42. The atomic weight of palladium. By G. H. Bailey, D.Sc., Ph.D., and Thornton Lamb	138	745
43. The action of sulphuryl chloride on acetorthotoluidide and acetparatoluidide. By W. P. Wynne, D.Sc.	139	1042

Received and printed in the Transactions during the recess.

44. Some homonucleal tri-derivatives of naphthalene (peridibromonaphthalene). By R. Meldola, F.R.S., and C. H. Desch	141	765
45. A method of measuring the vapour pressures of solutions. By Thomas Ewan, B.Sc., Ph.D., and W. R. Ormandy	141	769
46. The hydrazines of quinoline. By S. F. Dufton, B.A., D.Sc.	142	782
47. The origin of colour (IV). Note on the appearance of colour in quinoline derivatives and of fluorescence in quinine salts. By Henry E. Armstrong	143	789
48. Dicarboxyglutaconic acid. By S. Ruhemann, Ph.D., and R. S. Morrell	143	791
49. Action of nitric acid on anthracene (II). By G. A. Perkin and J. E. Mackenzie	144	865

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50. The behaviour of ethylene on explosion with less than its own volume of oxygen. By B. Lean, B.A., B.Sc., and W. A. Bone, B.Sc.	144	873
51. The lowering of the freezing points of cadmium, bismuth and lead when alloyed with other metals. By C. T. Heycock, M.A., and F. H. Neville, M.A.	145	888
52. Isolation of a compound of gold and cadmium. By C. T. Heycock, M.A., and F. H. Neville, M.A.	146	914
53. The resins of *Ficus rubiginosa* and *F. macrophylla.* By E. H. Rennie, D.Sc., and G. Goyder, jun.	146	916
54. The hydrolytic functions of yeast. Part II. By James O'Sullivan	147	926
55. Imidosulphonates. By E. Divers and T. Haga	147	943
56. Modification of Beckmann's boiling point method of determining molecular weights of substances in solution. By Joji Sakurai.	151	989
57. Anhydro-derivatives of citric and aconitic acids. By T. H. Easterfield and W. J. Sell	153	1003
58. Disubstituted semithiocarbazides. By Augustus E. Dixon, M.D.	153	1012
59. Studies on the interaction of bromine and toluene. Preparation and properties of ortho- and para-bromotoluene, and of the dibromotoluenes derivable therefrom. Ortho- and para-bromotoluenesulphonic acids. By A. K. Miller, Ph.D.	155	1023
60. Note on the constitution of Nevile and Winther's orthotoluidinesulphonic acid, and on the acids formed by sulphonating ortho-chloro- and bromotoluene. By W. P. Wynne, D.Sc.	155	1036
61. The action of iodine on a mixture of sulphite and thiosulphate. By Arthur Colefax, M.A., Ph.D.	155	1083
62. The methylic salts of camphoric acid. By James Walker, Ph.D., D.Sc.	156	1088

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63. Fluosulphonic acid. By T. E. Thorpe, F.R.S., and Walter Kirman	160	921
64. Note on the interaction of iodine and potassium chlorate. By T. E. Thorpe, F.R.S., and George H. Perry	161	925
65. The magnetic rotation of sulphuric and nitric acids, and of their aqueous solutions; also of solutions of sodium sulphate and lithium nitrate. By W. H. Perkin, Ph.D., F.R.S.	161	57*
66. Note on the refractive indices and magnetic rotations of sulphuric acid solutions. By S. U. Pickering	162	99*
67. The hydrate theory of solutions. Some compounds of the alkylamines with water. By S. U. Pickering	164	141*
68. The atomic weight of boron. By Emily Aston, B.Sc. (Lond.), and William Ramsay, Ph.D., F.R.S.	165	207*
69. Methoxyamido-1 : 3-dimethylbenzene and some of its derivatives. By W. R. Hodgkinson and Leonhard Limpach	166	104*

December 1st.

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70. The isolation of two predicted hydrates of nitric acid. By S. U. Pickering	185	136*
71. Anhydrous oxalic acid. By W. W. Fisher, M.A.	186	—
72. The production of orcinol and other condensation products from dehydracetic acid. By N. Collie, Ph.D., and W. S. Myers, B.Sc.	187	122*
73. Observations on the origin of colour and on fluorescence. By W. N. Hartley, F.R.S.	188	243*
74. The origin of colour. V. Coloured hydrocarbons and fluorescence: a reply to Professor Hartley's observations on the origin of colour and of fluorescence. By Henry E. Armstrong	189	—
75. The origin of colour. VI. Azobenzene. By Henry E. Armstrong	194	—
76. The reduction products of dimethyldiacetylpentane. By F. Stanley Kipping, Ph.D., D.Sc.	198	111*
77. The products of the interaction of zinc chloride on sulphuric acid and camphor. (Third notice.) By Henry E. Armstrong and F. S. Kipping	198	—
78. The Griess-Sandmeyer interactions and Gatterman's modification thereof. By Henry E. Armstrong and W. P. Wynne	199	—
79. Methods of observing the spectra of easily volatile metals and their salts, and of separating their spectra from those of the alkaline earths. By W. N. Hartley, F.R.S.	200	138*
80. Manganese borate, its constitution and properties. By W. N. Hartley, F.R.S., and Hugh Ramage	201	129*

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81. Jean Servais Stas and the measurement of the relative masses of the atoms of the chemical elements. By J. W. Mallet	204	1*

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PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

No. 105. Session 1891–92.

January 21st, 1892. Professor W. A. Tilden, F.R.S., Vice-President, in the Chair.

Messrs. L. W. Fulcher, Harry G. Myers, Ph.D., and Thomas Stephenson were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Frederick Fielding Bond, M.D., Rastrick, Yorks; William John Atkinson Butterfield, 10, Tressillian Crescent, St. John's, S.E.; Robert Brooke Floris, 18, Ridgway Place, Wimbledon, S.W.; Alfred Thomas Gailleton, Tulloch House, Perth, N.B.; William Percy Hatton, 73, St. Quintin Avenue, North Kensington; Lionel Manfred Jones, Beaumont House, Llanelly; William Cossar Mackenzie, Tewfikieh College of Agriculture, Ghizeh, Cairo; Charles Stephen Meacham, 62, Earl Street, Maidstone; Thomas Skurray, Abingdon, Berkshire; James Sykes, 76, Lockwood Road, Huddersfield.

Of the following papers those marked * were read:—

*93. "The estimation of oxygen dissolved in water." By Matthew A. Adams.

The author describes an apparatus in which the estimation of oxygen in water by Schützenberger's method may be carried out so as entirely to avoid the loss of oxygen by diffusion or its entry. The essential feature is a cylindrical laboratory vessel about 350 c.c. in capacity, 20 cm. long, and 5 cm. in diameter, provided with four small lateral tubulures midway from the closed ends. By means of these it is attached to two burettes, one containing the indigo carmine, the other hyposulphite solution, and also to a mercury reservoir and to a Y-tube, one branch of which is connected with a supply of the water to be examined, the other serving as an outlet for the water. The tubes are all controlled by pinchcocks. The water and the liquids for titration are sucked into the vessel by lowering the mercury reservoir, and are subsequently discharged by raising it again; the tubes passing into the vessel from the burettes are provided with india-rubber valves which prevent either reflux or diffusion taking place into the burettes.

The author then refers to the peculiar irregular manner in which the action is known to take place, and describes his own observations, giving the results both of experiments made in the manner directed by Schützenberger and in the indirect manner recommended by Roscoe and Lunt (*cf. C.S. Trans.*, 1889, 552). From the results he concludes that in estimating oxygen by the Schützenberger process, the result obtained is liable to differ according to the rate at which the determination is effected, it being always higher when the titration is quickly performed.

*94. "The luminosity of coal-gas flames." By Vivian B. Lewes.

The author has quantitatively studied the actions which lead to loss of luminosity in a Bunsen flame.

The volumes of varying mixtures of nitrogen and oxygen required to render 16·3 candle coal-gas non-luminous in a Bunsen burner are shown in the following table:—

Gas.	Volume of mixture required.	Composition of mixture.		Volume of oxygen present in amount required.
		Nitrogen.	Oxygen.	
1 vol.	2·30	1	nil	nil
"	2·30	5	1	0·38
"	2·27	4	1	0·45
"	2·02	3	1	0·50
"	1·49	2	1	0·50
"	1·00	1	1	0·50
"	0·50	nil	1	0·50

It is evident that until the percentage of oxygen reaches the amount present in the atmosphere, the diluting influence of the nitrogen is so strong that it prevents the oxygen having any practical effect in destroying luminosity; but that as soon as the quantity of oxygen present has risen above 25 per cent., then its activity has so far overcome the diluting influence of the nitrogen, that the latter has ceased to exercise any retarding influence on it.

In the case of other gases, the results are as follows :—

1 vol. of coal gas requires	0·5	vol. of	oxygen.
,, ,,	1·26	,,	carbon dioxide.
,, ,,	2·30	,,	nitrogen.
,, ,,	2·27	,,	air.
,, ,,	5·11	,,	carbon monoxide.
,, ,,	12·4	,,	hydrogen.

It is shown by experiment that dilution has the effect of destroying luminosity by greatly increasing the temperature necessary to decompose heavy hydrocarbons with liberation of carbon, so that at the temperature existing in a flame a volume of gas which undiluted will deposit 0·22 gram of carbon, when diluted with 2·3 vols. of nitrogen will only deposit 0·0013, but the higher the temperature, the less is the retarding action.

Experiments are next described in which the effect of the surrounding air on a flame is examined, and it is shown that, although the air introduced into a Bunsen is capable of bringing about certain changes in the flame when already burning in air, yet that it is quite unable by itself to keep the flame burning.

When a Bunsen burns under normal conditions, it has a bluish central zone, but if the air supply be largely in excess of that required for non-luminous combustion, the flame becomes smaller and fiercer with formation of a green central zone, which marks the change from a combustion in which the diluting influence of the nitrogen is still playing a certain part in causing non-luminosity, to a combustion in which the oxygen present having exceeded 0·5 vol. for each volume of gas, the nitrogen has ceased to exert any retarding influence.

By means of a platinum, platinum-rhodium thermo-couple, the temperature was determined in various parts of a non-luminous Bunsen flame, burning 6 cubic feet of coal-gas per hour.

Point in flame.	Flame rendered non-luminous by			Luminous flame from Bunsen.
	Air.	Nitrogen.	Carbon dioxide.	
½ inch above burner	54°	30°	35°	135°
1½ inch above burner	175	111.	70	421
Tip of inner cone	1090	444	393	913
Centre of outer cone	1533	999	770	1328
Tip of outer cone	1175	1151	951	728
Side of outer cone level with tip of inner cone	1333	1236	970	1236

A determination was made of the temperatures existing during the normal and also the "green centre" combustion of a Bunsen:—

	Blue inner cone.	Greenish inner cone.
Tip of inner cone	1090° C.	1575° C.
Centre of outer cone	1533 ,,	1600 ,,
Tip of outer cone.......	1175 ,,	1545 ,,
Side of outer cone level with the tip of inner cone................	1333 ,,	1511 ,,

Analyses of gases extracted from luminous flames at the points at which the temperatures had been determined show that in the inner zone there is a rapid diminution in the quantity of hydrogen as the gases ascend in the centre of the flame, a slow diminution in the quantity of the unsaturated and saturated hydrocarbons, and a large increase in the quantity of carbon monoxide in the first half of the flame. Analysis also revealed the fact that the outer non-luminous zone of a flame is not an area of complete combustion, but a portion of the flame in which the rapid entrance of air cools, dilutes and finally puts out the flame, allowing not inconsiderable amounts of methane, carbon monoxide, acetylene and even hydrogen, to escape unburnt.

The undoubted presence of acetylene in the products escaping from the flame, and the fact that the incomplete combustion of hydrocarbon gases always gives rise to the formation of this compound, suggested the idea that it might play an important part in the changes taking place in the interior of a flame, and experiments were made to ascertain if any appreciable quantity were formed during the destruction of the hydrocarbons in the flame gases.

	Total unsaturated hydrocarbons.	Containing acetylene.
Gas in burner	4·38 per cent.	0·035 per cent.
½ an inch above rim of burner..............	4·00 ,,	0·340 ,,
1½ inches above rim of burner..............	1·53 ,,	0·560 ,,
Tip of inner cone	1·98 ,,	1·410 ,,
Centre of luminous zone	0·45 ,,	0·045 ,,
Tip of luminous zone ...	nil	nil

It would therefore seem that in the interior of the luminous flame the hydrocarbons are at once attacked by the small proportion of air which penetrates into the inner zone, and that their incomplete combustion gives rise to acetylene, which by the time the top of the inner non-luminous cone is reached, constitutes over 70 per cent. of the unsaturated hydrocarbons present, some of the acetylene, however, having probably been formed by the interaction of methane and carbon monoxide. A small proportion of some more stable unsaturated hydrocarbon may remain undecomposed and penetrate into the luminous zone, but the chief effect is due to the acetylene which is decomposed by the higher temperature, and the liberated carbon being for a moment heated to incandescence gives luminosity to the flame.

In the case of a flat luminous flame from a No. 7 Bray burner, the following results were obtained :—

Portion of flame.	Total unsaturated hydrocarbons.	Containing acetylene.	Other unsaturated hydrocarbons.
½ an inch from burner ...	3·565 p. c.	0·115 p. c.	3·450 p. c.
1¼ inches from burner ...	2·063 ,,	1·303 ,,	0·760 ,,
1¾ inches from burner ...	1·393 ,,	1·133 ,,	0·260 ,,
2¼ inches from burner ...	trace	trace	nil

The author, therefore, regards the formation and decomposition of acetylene as the main cause of luminosity in a hydrocarbon flame, and if it be necessary, for purposes of simple description, to divide the luminous flame into zones. he thinks it would be most accurately regarded as consisting of three, viz. :—

I. The inner zone, in which the temperature rises from a comparatively low point at the mouth of the burner to about 1000° C., at the apex of the zone; in this portion of the flame various decompositions and interactions occur, which culminate in the conversion of the heavier hydrocarbons into acetylene, carbon monoxide being also produced.

II. The luminous zone, in which the temperature ranges from 1000° C. up to a little over 1300° C. Here the acetylene formed in the inner zone becomes decomposed by heat with liberation of carbon, which at the moment of formation is heated to incandescence by the combustion of the carbon monoxide and hydrogen, thus giving luminosity to the flame.

III. The extreme outer zone. Here, combustion being practically completed, the cooling and diluting influence of the entering air renders a thin layer of the flame non-luminous, finally extinguishing it.

This description of a luminous flame is of necessity far from complete, as it leaves out of consideration the causes which lead to the formation of the acetylene and the numerous interactions which take place between the products of combustion and the carbon in the upper zone of the flame.

The various actions which tend to cause the loss of luminosity in a Bunsen burner, in the author's opinion, may be summarised as follows :—

I. The chemical activity of the atmospheric oxygen, which causes loss of luminosity by burning up the hydrocarbons before they, in their diluted condition, can afford acetylene.

II. The diluting action of the atmospheric nitrogen which, by increasing the temperature necessary to bring about the partial decomposition of the hydrocarbons, prevents formation of acetylene, and in this way will, by itself, cause non-luminosity; in the normal Bunsen flame it acts by doing this until destruction of the hydrocarbons by oxidation has taken place.

III. The cooling influence of the air introduced, which is able to add to the general result, although the cooling is less than the increase in temperature brought about by the oxidation due to the oxygen in the air.

IV. In a normal Bunsen flame the nitrogen and the oxygen are of about equal importance in bringing about non-luminosity, but if the quantity of air be increased, then oxidation becomes the principal factor and the nitrogen practically ceases to exert any influence.

DISCUSSION.

Professor SMITHELLS said he thought Professor Lewes had made an important contribution to the subject of flame, though, perhaps, some of his conclusions were rash and open to criticism. He directed Professor Lewes' attention to the controversy on the cause of delumination of flames which had taken place between Blochmann and Heumann (*Annalen*, **207**, 167; *Ber.*, **14**, 1250, 1925, 2210), in which the whole question was very fully discussed and dealt with in a quantitative manner; also to Waldie's observations (*Phil. Mag.* (1838), No. 13, p. 88), in which delumination was effected by introducing luminous flames into atmospheres containing gases neutral to combustion. Waldie also made quantitative measurements, and sought to establish a relationship between diffusibility and deluminating effect. The abnormally great effect of carbon dioxide in destroying luminosity had been generally attributed, not to its high specific heat, but to its power of taking up carbon. Thus, for example, when mixed with an equal volume of ethylene in a flame, it was supposed that it underwent conversion into an equal volume of methane and a double volume of carbon monoxide—both of which would burn with practically non-luminous flames. Professor Lewes was in error in stating that Davy limited his theory to flames produced by hydrocarbons, for he explicitly stated that the luminosity of all flames ordinarily called luminous was to be attributed to solid particles, and in this respect left his theory open to Frankland's correction; he was also wrong in supposing that the theory that carbon is separated in a flame, owing to preferential combustion, was no longer held: it was, on the contrary (as the speaker could vouch from careful investigation), very widely accepted and taught. In a paper, which is in the press, it would be clearly demonstrated, he thought, that there are four distinct regions in a flame, however many gradations of chemical change there may be. He considered that the most important point in the paper which they had heard was that relating to the presence of acetylene in the flame. In his own experiments with ethylene he had also found that during luminous combustion scarcely any other hydrocarbons than acetylene are present in the aspirated gases. He was not satisfied, however, with Professor Lewes' proof of the escape of acetylene from ordinary luminous flames; whilst there was no *a priori* evidence against such an occurrence, unless the extraction of acetylene had been effected otherwise than by introducing cold aspirating tubes into the flame, it might be that the production of acetylene was a consequence of the method of experiment—it being well known that acetylene escaped freely from flames in contact with metallic surfaces. Accepting it as proved that the formation of acetylene in flames was an important factor in the origin of luminosity, the question was by no means worked out. It remained to discover exactly what became of the acetylene. Professor Lewes had kindly left the solution of this problem to the speaker, who, however, on his part, expressed a desire not to lay claim to too much undiscovered country, or to preclude Professor Lewes from the natural continuation of his interesting investigation.

Professor LEWES, in reply, said that he was perfectly aware of the work done by Heumann, Blochmann, Stein and Wibel. He must, however, dissent from the assumption that they had given quantitative proofs of many of their assertions.

The theory that carbon dioxide acted in destroying luminosity by converting ethylene into carbon monoxide and methane was, he thought, disproved, both by the experiments on the effect of heat in restoring luminosity to the flame and by the thermal changes taking place, as shown by the temperature of the diluted flame.

Undoubtedly Sir Humphry Davy went rather too far in his theory of luminous flames; but in a paper on the subject by him, in the *Philosophical Magazine* for 1817, he says: "The intensity of light of flames depends *principally* upon the production and ignition of solid matter in combustion," also "Flame is gaseous matter heated so highly as to be luminous," and "when in flames pure gaseous matter is burnt, the light is extremely feeble," so that it seems hardly just to insist that he considered solid matter *absolutely essential* to luminosity.

The determination of the combustible gases escaping unburnt from the outer zone of non-luminous flames, had been made by taking a platinum tube 2 mm. in diameter, bent into a ring, and pierced on the inside with minute holes; this ring was placed round the flame, but not in contact with it. and the products of combustion were aspirated through this, so that the acetylene could not be due to the action of the tube.

The speaker regarded the conversion of the hydrocarbons into acetylene as the chief cause of luminosity in flame, because acetylene was practically the only heavy hydrocarbon present in that part of the flame where luminosity commenced, and as it was known that acetylene was an endothermic compound, which could be decomposed by detonation, it seemed highly probable that it would be readily decomposed by heat and liberate carbon.

With reference to Mr. Groves' remark that when a Bunsen burner is alight at the bottom, a non-luminous flame is produced, as the acetylene escapes unburnt, such a flame could only have a low-light value.

*95. "The origin of flame coloration. A preliminary notice." By A. Smithells.

The author has found that the two cones of non-luminous flames separated widely from one another by the apparatus recently described by him in conjunction with Mr. Harry Ingle (*cf.* these Proceedings, 1891, p. 159), are differently affected by certain flame-colouring compounds. The most conspicuous case is that afforded by copper salts. In the inner cone of such a flame, copper salts produce no effect or only a lurid luminosity, without the slightest tinge of green, whilst in the outer flame the usual green colour is fully developed. Similar differences are noticed when using manganese salts. On introduction of gold chloride, the outer flame assumes a green and a blue tinge; the green, which is said to be the colour characteristic of gold salts, is not observable in the inner flame, but only a blue colour and general luminosity. The salts of the alkalis and alkaline earths appear to affect both cones alike.

As the inner cone is very much hotter than the outer one, the non-development in the former of the usual coloration is not to be attributed to any deficiency in temperature. The only explanation which suggests itself is that in some cases at any rate the coloration of flames is not to be attributed to the mere volatilisation of salts and the incandescence of their dissociated or undissociated vapour, but to a *flash* accompanying chemical combination. The particular combination, which in the case of copper gives rise to a green flame, may be that of the metal with oxygen. In the experiment cited, the inner cone of flame is surrounded by an atmosphere of carbon monoxide and dioxide, hydrogen, and water, which is capable of reducing copper compounds, even at a red heat, whereas the outer cone is surrounded by oxygen. The view here advocated is confirmed by the effects noticed on introducing copper oxide dust into the gas-supply. As the dust passes through the inner cone, a mere general luminosity due to solid particles is noticed, but when it reaches the outer cone it colours this a bright green. The copper oxide appears therefore to be reduced to metal in the inner cone, and to be reoxidised in the outer one, the act of oxidation giving rise to the green flash of light.

The hypothesis here broached, that flame colorations are due in some cases to chemical actions, and are not mere physical effects, requires for its support a greater array of facts and much more careful investigation than are here recorded. The author is engaged in extending the investigation, and only brings the matter forward at the present time after hearing that the flame-separating apparatus is likely soon to come into general laboratory use.

*96. "Note on the action of dilute nitric acid on coal." By R. J. Friswell.

In the last number of the *Berichte* (1891, p. 4085), Luzi has described the action of nitric acid on graphite, certain varieties of which, on treatment with the strongest fuming acid, yield a product which "puffs" like a nitro-compound when heated on platinum foil, and then swells out into prolonged vermiform coke-like masses. The writer feels that the substance in question sufficiently resembles one he has quite lately discovered to cause him to communicate the following note.

If bituminous coal in fine powder be covered with rather more than double its weight of 49 per cent. nitric acid, the mass rapidly becomes warm, and dense red fumes are given off. If 90 grams of coal and 200 c.c. of the acid are taken, the action is extremely brisk, and the frothing so violent that a 2000 c.c. flask is requisite to contain the mass. In about 30 minutes the action slackens, and heat being now applied the action is kept going at such a rate that a brisk evolution of gas continues; the solution is gradually raised to the boiling point and there maintained, the total time occupied being about six hours. The whole is now diluted, poured into a filter, and well washed. The filtrate consists of dilute nitric acid, with salts of calcium, iron, &c., in solution. The black residue on the filter is apparently unchanged coal. When washed free from acid, the residue is introduced into a flask and boiled with a dilute solution of sodium carbonate; nearly the whole dissolves, carbonic anhydride being briskly evolved. The resulting deep black-brown coloured liquid filters with great difficulty, but by careful treatment with water in deep vessels the insoluble matter from the 90 grams of coal was found to be 12·5 grams, consisting of coarse particles of coal, sand, &c.

One gram of coal, ground in an agate mortar and similarly treated, left only a trace of insoluble matter, so that, in some varieties of coal at least, the whole of the organic matter of the coal undergoes change.

The filtered solution on acidification with (preferably) hydrochloric acid, deposits a bulky, deep brown-black, flocculent precipitate, which is difficult to wash; it is insoluble as long as the wash-water contains small quantities of metallic salts or acids, but dissolves somewhat freely as the washing proceeds. In boiling distilled water it is fairly soluble, and separates therefrom on cooling in deep brown flocks.

The washed acid dried at 100° forms brilliant, black, friable masses, showing bright conchoidal fractures. If heated on platinum foil it puffs, swells slightly, and leaves a residue of carbon rather more bulky than its original mass, and almost as brilliantly black. The puffing is very like that of a nitro-compound with a very high carbon ratio; attempts to reduce it with zinc-dust and caustic soda, and with sodium amalgam have hitherto failed, and so have similar attempts with acid reducing mixtures. The presence of nitrogen is indicated in the usual manner on heating it with sodium; on submitting it to dry distillation with zinc-dust, hydrogen and cyanogen are evolved, a small aqueous distillate, smelling of ammonia and faintly of pyridine, and containing a very large quantity of hydrocyanic acid, being also obtained.

If the black acid be further treated with nitric acid, a brown acid is formed, which has not yet been examined.

At first sight the product appears to bear considerable analogy to the humic and ulmic acids described in vol. 15 of *Gmelin's Handbook*, particularly the one known as Sprengel's humic acid, obtained by extracting peat with ammonia. It however differs very much from that product in several particulars. It is not hygroscopic, it does not become insoluble on drying, and it does not yield acetic acid on dry distillation. As to the other humic acids, the substance from coal does not yield ammonia when boiled with alkalis, as they all, or nearly all, are said to do.

Lastly, there is very strong evidence in favour of the new product being a nitro-compound.

The possibility of attaining some evidence through the study of the substance in question as to the character of the constituent of coal from which it is derived is obvious.

97. "A pure fermentation of mannitol and dulcitol." By Percy F. Frankland, F.R.S., and Wm. Frew.

The authors have obtained a micro-organism which sets up a fermentative decomposition not only of mannitol but also of dulcitol, which has not hitherto been subjected to pure fermentation, and which has been found to resist the fermenting bacteria with which they have hitherto experimented.

The products of the activity of this organism are essentially the same in the case of the two substances in question, consisting of ethyl alcohol, acetic acid, succinic acid, carbonic anhydride and hydrogen, a notable proportion of formic acid being also obtained when the fermentation occurs in the absence of air and under slight pressure.

The carbonic anhydride and hydrogen evolved are approximately in the proportion of equal molecules or in that in which they are present in formic acid, and owing to the variable quantities in which the formic acid was discovered in the several fermentations, it is believed that more or less of the formic acid at first produced is subsequently decomposed with evolution of equal numbers of molecules of carbonic anhydride and hydrogen. This is the more probable, as in each of the fermentations the sum of the formic acid, hydrogen and carbonic anhydride approximately corresponds in molecules of formic acid to the amount of alcohol in molecules produced in the same fermentation.

The decomposition of the dulcitol and mannitol may be regarded as involving two independent sets of changes, viz., (*a*) $C_6H_{14}O_6 = 2C_2H_6O + CO_2 + CH_2O_2$ and (*b*) $C_6H_{14}O_6 = C_4H_6O_4 + C_2H_4O_2 + 2H_2$; but from the proportion which the acetic acid bears to the alcohol, it appears that two molecules are resolved in accordance with equation (*a*) for every one that is decomposed according to (*b*). The only marked discrepancy is in the case of the succinic acid, which was only found to about half the extent demanded by the equations given, but this discrepancy is probably due to the difficulty attending the accurate determination of succinic acid in a complex mixture of substances such as was present in these experiments.

In view of the products to which this organism gives rise, the authors propose for it the name of *Bacillus ethacetosuccinicus*. A detailed account of its morphological characters by Mrs. Percy Frankland is appended to the paper.

The authors mention that incidentally a compound was discovered of dulcitol with calcium chloride, $C_6H_{14}O_6,CaCl_2$.

98. "Synthesis of hexahydroterephthalic acid." By J. E. Mackenzie and W. H. Perkin, Jun., F.R.S.

By eliminating two molecules of carbon dioxide from the hexamethylenetetracarboxylic acid obtained in the form of ethylic salt by the interaction of ethylene bromide and the disodium derivative of ethylic butanetetracarboxylate, the authors have obtained as chief product the sparingly soluble hexahydroterephthalic acid of von Baeyer, together with a small amount of what is probably the isomeric acid.

99. "The magnetic rotation of dissolved salts." By W. Ostwald.

In a former paper (*C.S. Trans.*, 1891, p. 198) I pointed out that the unexpected results which Dr. Perkin obtained in his investigations on the rotatory power of solutions might be explained by means of Arrhenius's electrolytic dissociation theory, at the same time suggesting that the rotatory power of the ammonium salts of weak acids would probably show marked deviations from the calculated values.

Dr. Perkin, however, states in a recent communication (*ibid.*, 1891, 981) that such deviations do not exist, the actual differences being very small and comparable with those attending the formation of the ethereal salts of the same acids. Although I must confess that this result is contrary to my expectations, I am anxious to point out that the fault is mine, and not that of the dissociation theory. According to this theory, the condition of a substance is very different according as it can act as an electrolyte or not, *e.g.*, sodium chloride in the solid state or in aqueous solution; hydrogen chloride dissolved in amylic oxide (where it is a non-electrolyte) or in water, &c. In the case of the magnetic rotations of haloid salts, the differences foreshadowed by the dissociation theory are apparent as very considerable differences from the calculated values, and inasmuch as the former views did not take any account of such differences, I was right in saying that the dissociation theory is alone in accordance with Dr. Perkin's observations. The values for oxy-acids also differ from the calculated values, though in a much less degree; I expected such differences to be manifest also in the case of ammonia and the fatty acids, but Dr. Perkin has shown that the differences are quite insignificant.

As the dissociation theory does not lead to any numerical value or sign of the differences, the very low values observed by Dr. Perkin in the case of the fatty acids are not contrary to the theory, but suggest only the interesting question: on what qualities does the sign and the value of the variation of magnetic rotation attending the transition of non-electrolytic molecules into ions depend? In the case of haloid acids and salts, the variation is positive; in the case of the oxy-acids, negative; therefore, it is not surprising that molecules with nearly zero variations are also capable of existence. Investigation of a greater number of such cases will certainly throw light on this question.

A tolerably short method of testing whether my attempt to explain the facts of magnetic rotation by the dissociation theory is tenable, is the following. As the greatest differences are observed in the case of halogens between the ionic and the non-ionic state, an investigation of electrolytes containing halogen atoms, but not as ions, appears to promise most, *e.g.*, the salts of mono-, di- and trichloracetic acids, of chloric and iodic acids, potassium mercuric iodide, K_2HgI_4, &c. If in all these cases abnormal high values for the halogens should be obtained, I should not hesitate to confess that I have been on a false track.

100. "The dissociation of nitrogen peroxide." By W. Ostwald.

Availing himself of the data recently given by Cundall (*C.S. Trans.*, 1891, 1076), the author has compared the extent to which this compound undergoes dissociation when vaporised with that which it suffers when dissolved in chloroform; from the results he concludes that it behaves in accordance with Van't Hoff's generalisation that dissolved substances obey the same laws as gases. It appears, however, that in the gaseous state dissociation is far more advanced than in a chloroform solution.

101. "Corydaline." (I.) By James J. Dobbie, M.A., D.Sc., and Alexander Lauder.

Analyses of the alkaloid, as well as of its salts and derivatives, led Herm. Wicke (*Annalen*, 1866, **137**, 274) to assign to corydaline the formula $C_{18}H_{19}NO_4$. The authors have purified samples by repeated recrystallisation from a mixture of alcohol and ether, and have obtained the alkaloid in the form of flat, prismatic, colourless crystals, melting at 134·5°. In analysing it, they obtained results irreconcilable with Wicke's formula, $C_{18}H_{19}NO_4$, and propose instead the formula $C_{22}H_{25}NO_4$.

The iodhydride is easily obtained in pale-yellow coloured prisms by recrystallising from water the precipitate obtained when a solution of potassium iodide is added to one of corydaline hydrochloride.

The platinichloride and corydaline methiodide were prepared by the methods described by Wicke.

The results obtained on analysing these compounds corroborate those afforded by the alkaloid.

When heated with hydrogen iodide, one formula-weight of corydaline yields four molecular proportions of methyl-iodide, together with the iodhydride of a base which apparently bears the same relation to corydaline that papareroline bears to paparerine. On oxidation with potassium permanganate, corydaline yields a number of products which the authors are now engaged in investigating.

102. "Silver compounds of thiourea." By J. Emerson Reynolds, F.R.S.

In a paper on some derivatives of thiourea. published by the author in 1888 (Trans., **53**, 857) it was pointed out that a crystalline compound of silver bromide with thiourea, viz., $(CSN_2H_4)_2AgBr$, was obtained by the interaction of equimolecular proportions of silver nitrate and the new compound then described $(CSN_2H_5)_4NBr$. It was further stated that analogous compounds with other silver salts had been obtained by the same method as well as by direct union with thiourea, and that their detailed examination had cleared up certain obscure facts which were simply recorded in the author's earlier papers on thiourea.

The publication of a paper on the subject was deferred in the expectation of the completion of a new examination of the more interesting gold and platinum compounds, but the appearance of a paper by Kurnachow in a recent number of the *Berichte* on silver compounds of thiourea renders further delay undesirable, as that chemist refers only to the author's paper on thiourea, published 22 years ago.

In the course of the work of 1888, referred to above, the writer obtained the following compounds:—

$(CSN_2H_4)_3AgNO_3$. Beautiful long needles, melting at 141°, decomposing at 150° with separation of Ag_2S. Best obtained from an alcoholic solution containing 4 mols. thiourea to 1 mol. silver nitrate.

$(CSN_2H_4)_2AgNO_3$, a product of the partial decomposition of the previous compound by water.

$(CSN_2H_4)AgNO_3$. a precipitate obtained on mixing equimolecular proportions of its constituents. This is decomposed by water; and the author regards the silver precipitate mentioned in his 1869 paper as the probably indefinite product of too carefully washed 1 : 1 compound above mentioned: this being the view also taken by Kurnachow.

$(CSN_2H_4)_2AgBr$, fine prisms melting at 120—121°.

$(CSN_2H_4)AgBr$, a white powder.

$(CSN_2H_4)_2AgCl$, crystalline; melts at 170—171°, decomposing at 180°. This was also obtained by Volhard.

No. 1 : 1 compound was obtained with AgCl.

$(CSN_2H_4)AgI$, a white, crystalline precipitate. In this case the higher compound appears only to exist in solution of thiourea.

$(CSN_2H_4)_2AgCN$. Small crystals which discolour at 115° and melt to a dark liquid at 126° sharply.

All the foregoing substances readily afford Ag_2S when heated a few degrees beyond their melting points, or even before melting, as in the case of the silver cyanide compound.

ADDITIONS TO THE LIBRARY.

I. *Donations.*

On the History and Growing Utilisations of Tussur Silk, by T. Wardle. London 1891. From the Author.

Istituto Chimico della Regia Università di Roma. Richerche 1890—1891. Roma 1891. From the University.

Chemistry of the Carbon Compounds or Organic Chemistry, by V. v. Richter. Translated by E. F. Smith. 2nd American Edition from 6th German Edition. London 1891. From the Publishers.

Royal Society: Catalogue of Scientific Papers (1874—1883). Vol. IX. Quarto. London 1891. From the Royal Society.

Contributions to the Chemistry of Insect Colours, by F. H. P. Coste. London 1891. From the Author.

II. *By Purchase.*

Dei combustibili Minerali d'Italia e dello loro importanza economica, per G. Jervis. Torino 1879.

Dell' Oro in Natura, di G. Jervis. Firenze, Torino e Roma 1881.

Guida alle Acque Minerali d'Italia, di G. Jervis. Torino 1868.

ANNIVERSARY MEETING AND SECOND ANNIVERSARY DINNER.

The Anniversary Meeting will be held at *Four o'clock in the Afternoon* of Wednesday, March 30th next.

It is arranged that on the evening of the same day the Fellows and their friends will dine together at the Whitehall Rooms, Hôtel Métropole.

At the next meeting, on February 4th, the following papers will be read :—

" Osmotic pressure." By Professor Ramsay.

" The effect of certain salts on the boiling point of alcohol." By S. Skinner, M.A.

"The acid action of drawing-papers of different makes." By Professor Hartley.

" The isomeric α-bromocinnamic acids." By Dr. Ruhemann.

Issued 13/2/1892.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

No. 106. Session 1891-92.

February 4th, 1892. Professor A. Crum Brown, F.R.S., President, in the Chair.

Mr. George German was formally admitted a Fellow of the Society.

Certificates were read for the first time in favour of Messrs. Meredith Wynter Blyth, 17, Marlborough Hill, N.W.; Reginald Busby Brown, Ellerslie, Knighton Park Road, Leicester; Arthur Carey, Gateacre, near Liverpool; Haridas Garjari, M.A., Agra College, Agra, India; Ernest E. Milnes, Ashfield, Bradford; Arthur Trobridge, Langley, near Birmingham.

Of the following papers those marked * were read :—

*103. "Pedetic motion in relation to colloidal solutions." By William Ramsay, Ph.D., F.R.S.

Pedetic motion of small particles depends (1) on the size of the particles; (2) on their density; (3) on the nature of the medium in which they are suspended. An electrolyte does not cause the motion to cease at once, but the particles cohere when they happen to touch, and ultimately form clots or clusters. If an electrolyte be not present, the particles do not seem to touch. From observations with the microscope, it is calculated that a particle with a mass of $2{\cdot}8 \times 10^{-13}$ grams moves through approximately its own diameter $1{\cdot}4 \times 10^{-4}$ cm. in a second. Such a particle has one hundred billion times the estimated mass of a water molecule; hence, if its motion be produced by bombardment from water molecules, these must exist in complex groups of considerable mass, and of some stability. It is very unlikely that pedetic motion is the result of electric charges on the particles, because they appear to be uninfluenced by each other's motions; there is no obvious source of such electric potential; and, moreover, we know from Messrs. Linder and Picton's experiments the result of electrifying them: they are repelled from the positive or negative pole, according to their nature; but their pedetic motion is not interfered with, and is quite different in kind from the flow from the pole. An explanation of this repulsion has been given by Quincke (1861) and by Clausius (1879). The fact that pedesis is stopped by the addition of an electrolyte would appear to show that the water complices are disintegrated by the presence of ions; it may be that the individual water molecules are attracted by one or other ion, or by both.

The effect of pedetic motion in a liquid is to cause hydrostatic pressure; such hydrostatic pressure would be less on a membrane capable of penetration by the molecular aggregates or particles; and as the suspensions examined by Messrs. Linder and Picton and the colloids investigated by Graham will not pass through porous clay, they must exert pressure on its surface; the water having fairly free ingress and egress, due probably to the disintegration and the reformation of its molecular complices.

From actual observation of pedetic motion under the microscope, it cannot be doubted that the relative velocity of two particles depends on their mass; and if their volumes are approximately equal the less dense particle moves much more actively than the more dense. It would appear not in the least unlikely that equal numbers of equally sized particles would exert equal pressure, as in the case of gases.

In an article by Lothar Meyer (*Kgl. preuss. Akad. d. Wissensch.*, 1892, 26th November) on Osmotic Pressure, he points out the great discrepancy observed between all measurements of osmotic pressure (except those of Pfeffer on sugar) and the pressure calculated on the supposition that the space was filled with a gas at the same temperature; in all cases the observed osmotic pressure is too low, if it be supposed that ionisation occurs. There are three possibilities: (1) the so-called semi-permeable membrane acts as a sieve, and is quite impermeable to molecules over a certain volume; (2) the membrane is not impermeable, but allows molecules of different momenta to pass at different rates, as with gases of different densities and porous clay; and (3) there is combination of the dissolved substance with the membrane walls, transference through and dissociation of the compound at the interior surface of the walls, as with hydrogen and a palladium diaphragm. Tammann has shown the great probability of the truth of the last hypothesis.

I am disposed to conclude that solution is nothing but subdivision and admixture, owing to attractions between solvent and dissolved substance accompanied by pedetic motion; that the true osmotic pressure has probably never been measured; and that a continuous passage can be traced between visible particles in suspension and matter in solution; that, in the words of the old adage, *Natura nihil fit per saltum.*

DISCUSSION.

Mr. J. Y. BUCHANAN, having inquired whether muddy water, such as that flowing from the Rhone into the Lake of Geneva, would exhibit a higher density than the clear water when tested by a hydrometer; and Mr. FRISWELL having said that it was well known that it was impossible to exactly ascertain the density of oil of vitriol containing lead sulphate in suspension by means of a hydrometer, Professor RAMSAY said that as particles in pedetic motion exercise pressure, they necessarily tend to force the hydrometer bulb upwards, and thus cause an apparent increase in the density of the liquid.

Referring to the stoppage of dissolved substances by partly permeable membranes, Mr. HOWARD pointed out that the purification of water by sand filtration had been traced to the formation of growths on the surface of the sand; when these growths reached a certain stage, however, they ceased to act.

*104. "The acid action of drawing paper of different makes." By W. N. Hartley, F.R.S.

In a communication to the British Association, "On the fading of water-colours" (*cf. Chem. News*, **54**, 263, 1886), I showed that moisture and acidity were the chief causes of the fading of certain pigments. The acid in the air of towns is produced from sulphur in the coal, in the air of rooms from the excessive amount of gas which is burnt, and in certain colours according to their mode of preparation. It was suggested that even the slight acidity of drawing papers might be expected to facilitate chemical change, the action in each case being a gradual one. I had experimented with various kinds of the best paper in use, both of old and recent manufacture, and had come to the conclusion that such papers were invariably acid, even those of the most excellent quality. The fact was accounted for as follows:—The fibre of which the paper is made is steeped in dilute sulphuric acid, and the subsequent washing with pure water does not entirely remove the acid from linen fibre, of which the best papers are made. I have actually found fine linen to retain traces of acid after it has been steeped in frequently renewed pure distilled water for a period of three weeks. The acid seems to combine with the fibre, and the resulting compound is only slowly decomposed or dissolved by the action of water. Such linen gives a blue colour when an aqueous solution of iodine is dropped upon it. There was no intention to convey the idea that the paper contained free acid in such quantity that it could be easily removed by washing, or that it would affect *litmus paper*, which generally is not a sensitive agent. The samples of paper exhibited at the meeting were carefully tested in the following manner:—A pure and neutral solution of azolitmin prepared from litmus was allowed to drop upon the paper and soak into the fibres; the edges of the drops were then examined, and found to be red. The bulk of the liquid was then removed by a piece of the same paper, with the result that in every case a red spot was seen, which dried red. Another mode of testing was as follows: —A clear sable brush washed in distilled water was used for applying a wash of pure neutral azolitmin solution, as if it were a pigment; such washes turned red upon the paper.

Professor Church, in his valuable work on "*The Chemistry of Paints and Painting*," p. 290, published in 1890, remarks that he is unable to endorse my statement that the best drawing papers have an acid action. He finds, in fact, that sized papers are generally neutral to test-papers, and that inferior papers are more often slightly alkaline than acid.

As some doubts may be entertained as to the quality of the papers examined by me, it may be well to state that they were all of the best quality, most of them being of Whatman's make. That no question may arise on this point, I have tested the samples named below in three ways: first, by dropping litmus solution upon the paper; secondly, by washing with a sable brush; thirdly, by steeping strips of paper in pure distilled warm water, and testing the water for acidity, and also for sulphates. The acid action was recognised by a pure litmus solution, by an ordinary laboratory preparation and by a carefully prepared solution of helianthin, though this last agent is not very sensitive.

The results are identical with such as I obtained on former occasions. The description of the samples and their actions is as follows:—

1. Whatman's hand-made paper, 96 lbs., old make. Washes, acid; drops, acid; water, decidedly acid. Large precipitate with barium sulphate insoluble in dilute chlorhydric acid.

2. Whatman's double thick Imperial, 140 lbs. Washes, acid; drops, acid; water, decidedly acid. Large precipitate of barium sulphate, as with No. 1.

3. Whatman's double elephant, hand-made. Washes, acid; drops, acid; water, strongly acid. Large precipitate of barium sulphate, as with No. 1.

4. Whatman's hand-made, 72 lbs., 1887. Washes, acid; drops, acid; water, decidedly acid. Large precipitate of barium sulphate, as with No. 1.

5. Saunders' hand-made. Washes, acid; drops, acid; water, decidedly acid.

6. Hollingworth's machine-made paper. Washes, barely acid; drops of strong litmus neutral in colour; water, very slightly acid, almost neutral.

7. Arnold's unbleached, hand-made paper. Washes, acid.

No further test for acidity were recorded.

All these samples were procured from Mr. Spence, Lower Sackville Street, Dublin, especially for the purpose of these tests. It will be seen from these notes that there were good grounds for attributing an acid action to even the best of drawing papers. In other words, if a very sensitive solution of pure litmus be applied to paper in the same manner as a strong pigment, as for instance in delicate washes, the action is, in almost every case, distinctly acid; but if a drop of a strong solution be allowed to sink into the paper and dry up, its colour may be so slightly changed as to appear violet, leading to the inference that the paper is neutral. The strength of the solution of litmus, and the manner in which it is applied, must therefore be taken into account, because the quantity of the purple colouring matter in contact with the paper may be more than sufficient to overpower the red tint caused by the acid present in the moistened material. It is therefore extremely probable that there has been no difference between the opinions of Professor Church and myself, but only an incomplete understanding as to the degree of acidity of the paper. Solutions of helianthin painted on the various samples of paper gave at first a pure yellow tint, which gradually changed to a colour intermediate between rose-colour and yellow. Very dilute solutions, washed on freely, showed after some minutes a pale rose-colour, mixed with a yellowish tinge. A sufficiency of acid yields a fine rose tint with such a solution. Hollingworth's paper did not show in any degree an acid action with helianthin, although it gave a slight indication with litmus.

DISCUSSION.

Mr. **WADE** remarked that perhaps the sulphate detected by Professor Hartley was derived from thiosulphate, which, it was well known, was used as an antichlor in manufacturing paper.

Mr. **GROVES** said it would be desirable to know more of the history of the papers. Was gas burnt in the room in which they were stored, and were the sheets examined taken from the tops of the packets? If so, it was possible that the sulphuric acid was derived from the gas;

it would be desirable to test the centre portions of sheets taken from the middle of the packet.

Professor HARTLEY's remarks on this criticism are as follows :— The circumstances are not within my recollection, and I am unable to make enquiry at present, but drawing paper in sheets is kept in drawers, at a height of not more than three or four feet from the ground, and carefully protected from dust and damp. As a rule, the samples tested by me have been taken from the middle sheets of sketch blocks prepared from Whatman's hand-made papers, and purchased from Lechertier, Barbe and Co., Regent Street. Imperial and double elephant were the kinds most used. I am well acquainted with the effect of a sulphurous atmosphere on paper, but cannot think that the acidity to which I refer is to be attributed to such a cause.

105. "The interactions occurring in flames." A correspondence between Sir G. G. Stokes, Bart., F.R.S., and Henry E. Armstrong.

The following correspondence will serve as a contribution to the recent discussion of the chemistry of flames brought under the notice of the Society by Professor Smithells and Mr. Ingle, and by Professor Lewes. The paper referred to by Sir G. G. Stokes is entitled "On an optical proof of the existence of suspended matter in flames" (*cf. Proc. Roy. Soc. Edin.*, 1891). It was reproduced in *Nature*, **44**, 263, 1891.

"4, Windsor Terrace, Malahide, Ireland,
"23*rd September*, 1891.

"DEAR DR. ARMSTRONG,

"I enclose a little optico-chemical paper, that is to say, one in which the method is optical, but the results are of interest, such as they have, rather from a chemical point of view. I use, to express it in short terms, a flame as a screen on which to receive an image of the sun.

"The reaction mentioned in the P.S. is to be taken as a specimen of reactions of the kind, for though it probably takes place, there are doubtless others also, as there are a lot of compounds found in the interior of the flame.

"I read the other day your address to the Junior Engineering Society, in which you speak of oxygen as combining with hydrogen in preference to carbon; I should have supposed it would have been the other way. Not only does the facility with which steam is decomposed by glowing carbon favour this view, but it seems to me to fit better with the phenomena of flames. According to my notions, we must carefully distinguish between the changes which take place in the partial combustion of a molecule and those which are produced in neighbouring molecules as a result of the heat thus produced. We may, for the sake of a name, call the former pure-chemical, and the latter thermo-chemical. The action of the heated walls of a tube is of the thermo-chemical kind; it involves a regrouping of the existing molecules under the molecular agitation of a hot body, without bringing a fresh reagent (suppose oxygen) into play from outside the molecule. I think that in the blue base of the flame of a candle, where oxygen is plentiful, we have pure-chemical changes. The blue shell invests for a little way the highly luminous shell, like a calyx investing a corolla, and I think the thin shell of glowing carbon, to which the bulk of the light is due, owes its origin to a thermo-chemical change, the heat being derived from the combinations with oxygen which take place just outside it.

"I imagine that the hydrocarbon spectrum is due to a gas formed by a pure-chemical as distinguished from a thermo-chemical change. But what gas is it? It is commonly supposed to be acetylene. To me it seems more probable that it is marsh gas, formed by a pure-chemical, not a thermo-chemical, change. According to my notion, this unknown gas (x, say) is a hydrocarbon, which when burnt without admixture of other hydrocarbons would show but feebly if at all the hydrocarbon spectrum. More especially might this be expected to take place if it were burnt at a reduced pressure, or considerably diluted with, say, nitrogen. For in order that x should show its spectrum its molecule must be in a state of violent agitation, which it might be expected to be if it had been born as a result of partial combustion, but would not be merely because it was going to be slain by union with oxygen.

"I have not seen a statement as to the spectrum of marsh gas, as pure as may be, when burnt. Perhaps you know about it. As hydrocarbons in general (I don't know how it is as to marsh gas) show the same spectrum, x must be some gas of a simple kind formed in the process of partial combustion, though probably (at least under ordinary circumstances) itself burnt almost immediately afterwards.

"Yours very truly,
"G. G. STOKES."

"*January* 18*th*, 1892.

"DEAR SIR GEORGE STOKES,

"The question of the manner in which hydrocarbons are burnt, raised in your letter, has recently (on December 3rd, 1891) been brought under discussion at the Chemical Society by Professor Smithells in two papers dealing with the structure and chemistry of flames; the conclusions at which he arrives are practically identical with yours.

"In making (in 1887) the statements to which you refer, I was, to a certain extent, but retailing a not uncommon opinion, although probably I was led to give prominence to the idea that hydrogen is the more combustible constituent of a hydrocarbon by the circumstance that a gas, such as methane, CH_4, yields acetylene, C_2H_2, as one of the products of its incomplete combustion; it is possible that this latter may be formed by the agency of heat alone, but I certainly am inclined to regard its production as due to partial removal of the hydrogen from CH_4 by oxygen, the more so, as Dr. Miller and I were unable to detect acetylene in oil gas manufactured by passing petroleum hydrocarbons through highly heated retorts (*cf.*, *C.S. Trans.*, 1886, 80). Clearly, however, the case is one about which we can only reason at present; a crucial experiment which would afford a solution of the problem will not be easily devised, I think.

"At the close of 1886, when my address was written, we were but beginning to realise that the phenomena of combustion are far less simple than had up to that time been taught. Had I spoken of the subject a year or two later, I should undoubtedly have adopted a less dogmatic style. Still, while admitting that the facts do not justify the assertion that oxygen combines with hydrogen in preference to carbon when a hydrocarbon is burnt with insufficient oxygen, I am unprepared at present to accept the alternative view which both you and Professor Smithells advocate, that the carbon is the more combustible; I think the actual condition of affairs is far less simple than is expressed in the statement of either of these views.

"In the case of the changes attending combustion, you would draw a distinction between "pure chemical" and "thermo-chemical" changes. It is impossible to deny that such a differentiation of the changes is seemingly necessary, but perhaps after all the difference is but superficial.

"I cannot help thinking there is very little opportunity in flames for simple heat changes to occur; the molecules of *different kinds* are so mixed up together. Thus opportunity is given for interactions to occur, the end result of which is the same as that of a simple heat change of the chief substance concerned, merely because a change occurring at one moment is reversed the next, and so escapes notice. In this way contiguous molecules may play the part of surfaces, and that such actions are of primary importance in the case of "decompositions" as well as in the case of "compositions," there can, I think, be little doubt. Thus it appears to be established that a pure mixture of carbonic oxide and oxygen is incombustible; is it not therefore reasonable to suppose that under parallel conditions *pure* carbon dioxide is unresolvable into carbonic oxide and oxygen? Again, the results of recent experiments by Victor Meyer seem to prove that, as I have long suspected, the formation of water from hydrogen and oxygen is not the simple phenomenon it is represented to be by the simple equation $2H_2 + O_2 = 2H_2O$; and conversely it is well known that the extent to which the dissociation of water takes place depends on the character of the surface in contact with which it is heated, and not merely on the temperature. In fine, it seems permissible to doubt whether under the conditions prevailing in flames carbon is ever separated by simple heat changes; at all events, there is at present no evidence compelling us to conclude that it is.

"Professor Smithells contends that probably carbon has a higher heat of combustion than hydrogen; this may be, but in the absence of all data from which the heats of combustion of *atomic* carbon and hydrogen can be inferred, we cannot, with safety, base any argument on thermochemical values. But even if it have, it does not follow that carbon is not liberated by partial combustion of hydrocarbons. It is not merely a question of the relative affinities of carbon and hydrogen for oxygen. The carbon would not, I imagine, be atomic carbon, but that complex molecular form which occurs in the flame in the solid state, and being incandescent renders it luminous. The genesis of such carbon is expressible by an equation such as

$$xCH_4 + xO_2 = C_x + 2xH_2O.$$

Professor Smithells takes no account of the heat evolved in the formation of C_x from xC. I may also point to the superior stability at high temperatures of CO_2 as compared with CO as remarkable, seeing that it is the more complex molecule, especially as there is some ground for the belief that proportionally more heat is evolved in the fixation by carbon of the first than of the second atom of oxygen (*cf. Phil. Mag.* [5], **23**, 103, Feb., 1887). The probable explanation, as Berthelot has suggested, is that in this case, also, the decomposition of CO is promoted by the tendency of carbon atoms to combine.

"It is also to be remembered that, although carbonic oxide as well as carbon and steam appear to interact readily enough if the temperature be sufficiently high, dry carbonic oxide and carbon do not burn in dry oxygen; nothing better illustrates the difficulty of drawing conclusions in these cases than such facts as these.

"There is another point of view from which the phenomena may be regarded, from which it would seem that it is impossible to define either constituent of a hydrocarbon as the more combustible, except in a purely conventional sense. We may liken the interchanges occurring in an oxygen-methane mixture to those that occur in a cell in which two like electrodes are immersed in two different electrolytes—an aluminium acid-alkali cell, such as Wöhler (?) proposed, for example. The oxygen molecule O_2 corresponds to the aluminium, the hydrogen and carbon of the methane to the acid and alkali; and just as the aluminium is attacked in two ways, so the oxygen may conceivably become distributed between the carbon and hydrogen. The formation of the two aluminium compounds is independent of the relative affinity to aluminium of the radicles of the acid and alkali, and in like manner that of the two oxides from methane would be conditioned by the orientation of the oxygen atoms relatively to the carbon and hydrogen atoms of the hydrocarbon; for we may assume, I think, that the colliding oxygen and hydrocarbon molecules conjugate if only during a very brief interval of time, and that interaction is indeed a consequence of the opportunity thus given to the atoms to regroup themselves.

"There appears to be no doubt that surfaces of various kinds—I would even include gaseous surfaces—play an all-important part in promoting all kinds of *reversible* changes; but it is a fair question for discussion whether their action is not also of a "pure chemical" character. The fact that the nature of the surface is of moment is in favour of the view that it is—the surface must be a *compatible* one: the separation of hydrogen from a hydrogen compound being especially promoted by platinum, which undoubtedly has a strong affinity for hydrogen, and that of oxygen being promoted by silver, which, at high temperatures, is known to absorb this gas. On the other hand, copper, although so readily oxidisable, does not appear to promote the decomposition of water. Even in such a case as that of the dissociation of carbon dioxide by red-hot porcelain, it is conceivable that the porcelain may exert an attraction over atomic oxygen sufficient to induce its separation from carbon. I, therefore, am not satisfied that the action of the heated walls of a tube is, as you suggest, strictly of the thermo-chemical kind.

"There is a striking passage in Faraday's paper on the influence of platinum in promoting the interaction of hydrogen and oxygen (*Exp. Res.*, Series VI, paragraph 656, November, 1833), which shows that he had clearly realised how important is the influence of surface action even in the case of flames. He says:—

"'I have pursued this subject at some length, as one of great consequence, because I am convinced that the superficial actions of matter, whether between two bodies, or of one piece of the same body, and the actions of particles not directly or strongly in combination are becoming daily more and more important to our theories of chemical as well as of mechanical philosophy. In all ordinary cases of combustion it is evident that an action of the kind considered, occurring upon the surface of the carbon in the fire, and also in the bright part of a flame, must have great influence over the combination there taking place.'

"Regarding the interactions in flames as consisting in a series of simultaneous and consecutive explosions, of which we can only examine the final steady state, it seems to me that the phenomena are necessarily of an excessively complex character, and that their appreciation and successful interpretation must tax our powers of mental analysis in a very high degree. It will certainly be unwise at present to infer that the oxidation of the hydrocarbons, or the separation of carbon and also of hydrogen from them, takes place entirely in any one way.

"Yours very truly,
"HENRY E. ARMSTRONG."

"*21st January*, 1892.

"DEAR PROFESSOR ARMSTRONG,

"Perhaps I may be allowed to add a few words in explanation of what I meant by thermo-chemical change. I had not in view thermic measurements. I will endeavour to explain my ideas by an example. Let us contrast (*a*) the formation of water from mixed oxygen and hydrogen, (*b*) the formation of acetylene and hydrogen from marsh gas at a high temperature. In both cases alike molecular agitation is required to bring about the change; in (*a*) if the change be brought about at one point, the consequent agitation supplies the requisite disturbance to the neighbouring molecules, and the change is propagated with explosions; but in (*b*) I picture to my own mind the change as taking place in this way. When sufficient heat is supplied to the gas from without, the collisions of the molecules of the marsh gas become sufficiently violent to allow the carbon atoms in a pair to get into a condition in which their tendency to self-combination comes into play, and in the coalescing a portion of the total hydrogen in the pair is thrown off. But the continuance of this change is dependent on a continuous supply of heat from without, under which it is gradually effected. I should call (*a*) a pure-chemical change, even though heat at one point is necessary to start it, and I should call (*b*) thermo-chemical, even though chemical affinities are concerned in it.

"The results of Professor Smithells seem to me to make it probable that x may be carbonic oxide.

"Yours very truly,
"G. G. STOKES."

106. "Properties of alcoholic and other solutions of mercuric and other chlorides." By S. Skinner, M.A.

The author has determined the variation in the boiling point of alcohol produced by dissolving in it mercuric, lithium, magnesium and calcium chlorides, as well as the variation in the boiling point of a solution of hydrogen chloride of constant boiling point produced by mercuric chloride. He has also studied the distribution of mercuric chloride between the two solvents water and ether.

The results indicate that mercuric chloride affords a case in which the measure of the property is a simple function of the quantity of salt present, whereas in the case of the other chlorides the measure of the property involves some higher power.

107. "The isomeric α-bromocinnamic acids." By S. Ruhemann, Ph.D., M.A.

An account is given of experiments on the action of ammonia and phenylhydrazine on the ethereal salts of the two isomeric bromo-acids obtained on withdrawal of hydrogen bromide from dibromhydrocinnamic acid. Whereas the ethylic salt of α-bromocinnamic acid and ammonia readily interact, yielding α-bromocinnamonamide, the α-isocinnamate is scarcely affected by ammonia.

Both salts are converted by phenylhydrazine into a compound of the formula $C_{15}H_{11}N_3O$, the change taking place less readily in the case of the iso-salt. The author regards this product as cinnamylphenylazimide; the same substance is more readily prepared by interaction of ethylic dibromhydrocinnamate and phenylhydrazine. In both cases the yield of azimide is but small, the main product being a compound of the formula $C_{24}H_{18}N_4O_2$, probably the imide of dicinnamylphenylazimide. The author discusses the manner in which this compound is formed.

ANNIVERSARY MEETING AND SECOND ANNIVERSARY DINNER.

The Anniversary Meeting will be held at *Four o'clock in the Afternoon* of Wednesday, March 30th next.

It is arranged that on the evening of the same day the Fellows and their friends will dine together at the Whitehall Rooms, Hôtel Métropole.

At the next meeting, on February 18th, there will be a ballot for the election of Fellows, and the following papers will be read :—

"A search for a cellulose-dissolving (cytohydrolytic) enzyme in the digestive tract of certain grain-feeding animals." By H. T. Brown, F.R.S.

"Some experiments on alcoholic fermentation." By A. J. Brown.

"Limettin." By Professor Tilden, F.R.S.

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CERTIFICATES OF CANDIDATES FOR ELECTION AT THE NEXT BALLOT.

N.B.—The names of those who sign from "General Knowledge" are printed in *italics*.

The following Candidates will be balloted for on Thursday, February the 18th :— 1892

Adams, Arthur,

Broomfield Place, Smethwick.

Science Teacher. Some years' experience in teaching Science, mainly Chemistry; following a two-years' course in Chemistry at Mason College, under Dr. Tilden; as Priestley Scholar of the Birm. and Mid. Inst.; 1st Honours in Chemistry, Theoretical and Practical, at Science and Art Dept. Exam.

William A. Tilden. Wm. Whitehouse. Thomas Turner.
William Tate. W. W. G. Nicol. William W. Butler.

Adams, Frederick Edward,

Town Hall, Bolton.

Public Analyst and Medical Officer of Health. M.D. (Honours), Royal University of Ireland. D.P.H., University of Cambridge. Public Analyst for the County Borough of Bolton.

Maxwell Simpson. C. O'Keeffe.
D. J. O'Mahony. G. Russell Beardmore.
Thomas Farrington. *J. Hart.*

Bond, Frederick Fielding,

Rastrick, Yorks.

Surgeon and Medical Officer of Health. M.D., C.M, Edinburgh, Medallist in Prac. Chem., Honours in Theoretical Chem., and D.P.H., Royal Colleges of Physicians and Surgeons, London. Medical Officer of Health—my duty to perform Water Analyses and give evidence when necessary.

Alex. Crum Brown. James R. Kaye. Austin Keen.
Richd. Reynold. E. Normam Langham.

Butterfield, William John Atkinson,

10, Tressillian Crescent, St. John's, S.E.

Analytical Chemist. Studied Chemistry in the Laboratories at the Museum and at Christ Church, Oxford, for 3½ years, and obtained Honours in Chemistry in the Final Honour School of Natural Science at Oxford University. An Associate of the Institute of Chemistry. Recently engaged in analytical work at the Beckton Gas Works.

A. Vernon Harcourt. Arthur Colefax. Bertram Blount.
Samuel Rideal. Arthur G. Bloxam.

Collins, Hugh Brown, B.Sc., C.E.,

West Balgray, Glasgow.

Metallurgical Chemist. Studied Chemistry for three years in the University of Glasgow, and has taken up, specially, Metallurgy and Technical Chemistry.

John Ferguson. J. T. Bottomley. G. G. Henderson.
Adam Elliot Black. *Edmund J. Mills.* *David Wilson, jr.*
J. B. Readman.

Darbishire, Francis V.,

59, Elisiemstrasse, Dresden.

Student of Chemistry. Studied Chemistry for four years at Balliol College, Oxford, and obtained Honours in the Final School of Natural Science, June, 1881, and is now continuing his studies at Leipzig.

John Conroy. A. Vernon Harcourt. D. H. Nagel.
V. H. Veley. *J. E. Marsh.*

Floris, Robert Brooke,

18, Ridgway Place, Wimbledon.

Has been for the past three years a Student of Chemistry at University College, and has passed the Intermediate Science Exam. at University of London.

William Ramsay. John Norman Collie.
R. T. Plimpton. Boverton Redwood.
C. F. Baker. *Watson Smith.*

Gailleton, Alfred Thomas,

Tulloch House, Perth, N.B.

Forster Research Scholar in the Chemical Laboratory, University College, Dundee. For upwards of two years a Student of Chemistry and other Sciences at University College, Dundee; prizeman in the senior classes of Inorganic, Organic, and Practical Chemistry, as well as in that of Practical Dyeing.

Percy F. Frankland. Fred. J. Hambly.
James R. Appleyard. Jno. Alexander.
John Foggie. John S. Lumsden.
Rufus D. Pullar.

Hatton, William Percy,

73, St. Quintin Avenue, North Kensington.

Chemist to Messrs. W. R. Hatton & Sons, Chemical Manufacturers. Student of Chemistry for $9\frac{1}{2}$ years. 3 years at Westbourne Park Institute under Mr. F. W. Brown. 2 years at Birkbeck Institute under Mr. Chapman Jones. $4\frac{1}{2}$ years at Finsbury Technical College under Professor Meldola. Holder of four Government Certificates for Inorganic and Organic Chemistry. 1st Prize Inorganic Chemistry, Finsbury Technical College. Holder of Certificates from Finsbury Technical College for both Inorganic and Organic Chemistry. Member of the Society of Chemical Industry.

Chapman Jones. Fredk. Wm. Brown. R. Meldola.
Charles E. Cassal. *William H. Martin.* *George Smith.*
R. Mullineux Walmsley. *B. Henry Gerrans.*

Hendrick, James,

Laurel Cottage, Watermoor, Cirencester.

Lecturer on Chemistry at the Royal Agricultural College, Cirencester. Bachelor of Science, London University, Honours in Chemistry, Associate of Institute of Chemistry, by Examination. Lecturer on Chemistry and Chief Assistant to Professor Kinch at the Royal Agricultural College.

Edward Kinch. John M. Thomson.
G. Stillingfleet Johnson. Herbert Jackson.
Arthur G. Bloxam. Frank Gossling.
Bertram Blount.

Hewlett, John C.,

40, 41, 42, Charlotte Street, E.C.

Chemical Manufacturer. Engaged practically in manufacturing chemicals and pharmaceutical preparations, and in analytical work connected therewith, for more than 20 years.

David Howard. Thomas Tyrer. Boverton Redwood.
John Moss. Thomas Morson. Alfred White.
Chas. Umney. *Fred. W. Fletcher.*

Hollingshurst, Henry,

2, Jeptha Road, East Hill, Wandsworth.

Late Managing Partner of Hamilton & Co.; now Manager of the Crown Chemical Works, Manufacturing Chemists, Wandsworth, S.W. Have invented several processes for the successful treatment of Waste Products for Manures, notably sewage matter, saccahrine refuse (cake and scum), cotton seed, wool waste, mill wastes (collecting dusts and utilising same), together with spirits, barks, limes, &c. Some thousands of tons of these materials are now successfully manipulated and sold annually, with a guaranteed analysis from 30s. to £3 per ton. Also in the working of Carbolic Acids, various grades, soluble and insoluble, in many forms. Carbolic and Sulphurous Powders of high strengths at low costs. Also Petroleum Products, Petroleum Jelly, Lubricants, &c., &c.

A. B. Griffiths. P. A. Estcourt. Geo. A. Pingstone.
John Muter. L. de Koningh. *Thomas A. Pooley.*
Herbert Pilkington. *Alexander Hay.*

Jones, Lionel Manfred,

Beaumont House, Llanelly.

Student at the Research Laboratory of the Royal College of Science. Has studied Chemistry at the Royal College of Science, S. Kensington, for four years. B.Sc. (with First Class Honours in Chemistry) London University; Associate (in Chemistry) of the Royal College of Science.

T. E. Thorpe. W. P. Wynne. Chapman Jones.
A. E. Tutton. William Tate.

Lucas, Frank William, M.A. (Lond.), B.Sc.,

183, Belle Vue Road, Leeds.

Schoolmaster. Teacher of Chemistry at the Roan School, Greenwich, &c., for 10 years. Bachelor of Science Degree, London University. A wide study of Chemical Philosophy for a Thesis (written in 1890) for D.Sc. in Philosophy, Lond. Univ. Advanced preparation for the 1st Doctor of Science Exam. (Lond. Univ.), (equivalent to 1st Class Honours B.Sc.) in Chemistry. Preparation for Doctor of Science Exam. in Chemistry, Lond. Univ. Long study of scientific postulates, methods and hypotheses, of ancient cosmic theories and their development, of the Evolution Theory in its widest range, as included under Logic, Epistemology, Philosophy, &c., for the M.A. Degree, Lond. Univ., in which the *2nd* place was won.

Sydney J. Harris. Ed. Rawlins. B. A. Burrell.
George Ward. *Thomas Fairley.*

Luckett, Albert Henry,

Brighton College, Brighton, Sussex.

Schoolmaster. Lecturer on Chemistry. Teacher of Chemistry at Roan's School, Greenwich, from 1880—1888. Science Lecturer at Brighton College from 1888 to the present time.

Robert H. Davies. Thomas A. Pooley. A. B. Griffiths.
F. E. J. Cridland. *Thos. W. Salter.* *James Mason.*

Mackenzie, William Cossar,

Tewfikieh College of Agriculture, Ghizeh, Cairo.

Teacher of Chemistry. Professor in the Tewfikieh College of Agriculture, Ghizeh, Cairo, Egypt; four years Assistant to Mr. J. Falconer King, F.I.C., Edin., City Analyst; one year Chemist to Linlithgow Oil Works Company; Hope Prize Scholar, Hope Prizeman, Vans Dunlop Scholar and student under Prof. Fittig, Strassburg, and Prof. Märcker, Halle, A. S. Doctor of Science of Edinburgh University; Lecturer on Agricultural Chemistry at the Durham College of Science, and then Professor of Chemistry at the Tewfikieh College of Agriculture, Cairo.

John Hunter. P. Phillips Bedson.
Alex. Crum Brown. Leonard Dobbin.
James Walker. Saville Shaw.

McFall, John Edward Whitley,

Bankfield Road, West Derby, Liverpool.

Assistant Chemist to Messrs. Idris and Co., Manufacturing and Export Chemists, London. Formerly Demonstrator in Practical Chemistry, Manchester College of Chemistry and Pharm. For past six months engaged on original research work for Messrs. Idris and Co.

T. Howell Williams. Chas. Turner. W. H. Symons.
George S. Taylor. *J. Hughes.*

Meacham, Charles Stephen,

62, Earl Street, Maidstone.

Chemist to Messrs. Fremlin, Bros., Pale Ale Brewery, Maidstone. Chief Chemist to Messrs. Fremlin, Bros., during past six years. Laboratory training at Lichfield. Engaged in chemical and brewing work at Lichfield Brewery Co.'s Stout Brewery, Lichfield, for period of seven years; 2nd Medallist in "Brewing," City and Guilds of London, 1882; joint author of essay on "Hops, their Deterioration and Preservation," which was awarded 2nd Prize by the Honourable Company of Brewers of the City of London, in open competition. At present engaged in researches in reference to the chemistry of brewing at Maidstone.

Charles E. Cassal. Mahew A. Adams.
John Heron. Horace T. Brown.
E. R. Moritz. Walter J. Sykes.
Lionel W. Stansell. Laurence Briant.
Leonard Temple Thorne.

Millar, James Hill,

13, Waterloo Road, N. Wolverhampton.

Student of Chemistry. Associate of the Institute of Chemistry. Tangye Scholar in Chemistry in the Mason Science College, Birmingham. Joint author (with J. J. Sudborough) of Paper on "The Action of Heat on Nitrosyl Chloride" (*Trans. Chem. Soc.*). February, 1891.

William A. Tilden. W. W. J. Nicol. Thomas Turner.
T. Rhymer Marshall. James Spilsbury.

Mond, Robert Ludwig,

The Poplars, 20, Avenue Road, Regent's Park, N.W.

Research Chemist and Physicist. B.A. Cantab. F. Roy. Soc. Ed.

Ludwig Mond. William Ramsay. Carl Langer.
James Dewar. Thos. Tyrer.

Myers, William Shields,

New York, U.S.A.

Student. Bachelor of Science, Rutgus College, New Brunswick, New Jersey; three years' study of Chemistry in America; one year in Berlin, under Prof. H. Wickelhaus.

William Ramsay. R. T. Plimpton.
John Norman Collie. Watson Smith. C. F. Baker.

Pullinger, William,

27, Queen's Road, Oldham.

Studying and Teaching Chemistry. Was elected to a Natural Science Scholarship at Balliol College, Oxford, in 1886, and obtained a first class in the final honour School of Natural Science, in 1890. Studied at Tübingen for a year, and is the author of a paper on "The Volatile Platinum Compounds" (*Journ. Chem. Soc.*, **50**, p. 598. Demonstrator in the Balliol College Laboratory, Oxford, 1891.

A. Vernon Harcourt. John Conroy. D. H. Nagel.
V. H. Veley. J. E. Marsh.

Parry, Ernest John,

Brooklands, Bensham Manor Road, Thornton Heath.

Bachelor of Science. Bachelor of Science, with honours in Chemistry, London University; holder of Gilchrist Scholarship in Chemistry and of nine certificates (Government and others) in Chemistry; Past Student in the following laboratories:—Galew Works, 1888—9; Guy's Hospital, 1889—90; Birkbeck Laboratory, 1890—91.

Charles E. Groves. John Moss. William A. Tilden.
Frank Gossling. Geo. Chaloner.

Rothwell, Chas. Fredk. Seymour,

82, Mawson Street, C-on-M., Manchester.

Technical Chemist. Chemist in Print Works (Messrs. E. Potter and Co., Winting Vale); late Chemist in an Alkali Works, and two years laboratory assistant to Mr. George H. Hurst, F.C.S.; formerly Lecturer on Chemistry at the Science and Art School, Lower Mosley Street, Manchester, the Technical School, Stalybridge, and the Hyde Mechanical Institution. Honoursman in Theoretical and Practical Inorganic Chemistry and Practical Organic Chemistry; 1st class Advanced Organic Chemistry (Science and Art Dpt.); winner of the "Union of Lancashire and Cheshire Institutes" prize on Chemistry.

George H. Hurst.
Gibson Dyson.
W. R. Hodgkinson.
James Hulme.
R. L. Taylor.
A. E. Tutton.
Robt. R. Rothwell.
H. Lloyd Snape.
John Angell.

Sandercock, Thomas John Buckler,

Sidcup College, Sidcup, Kent.

Schoolmaster. Headmaster. Student, 15 years. Lecturer on Practical and Agricultural Chemistry, 10 years, at East Devon County School, and Grammar School, Teignmouth; Headmaster, Sidcup College; late Headmaster, Grammar School, Teignmouth.

J. Vincent Elsden.
Harry Grimshaw.
W. Bezant Lowe.
Joseph Gaskell.
A. Percy Smith.
Horace F. Cheshire.

Schofield, James Alexander,

University of Sydney, New South Wales.

Demonstrator in Chemistry and Metallurgy, University of Sydney. National Scholar, Royal College of Science; and Associate of the Royal School of Mines.

T. E. Thorpe.
Edwin J. Ball.
W. P. Wynne.
A. E. Tutton.
Chapman Jones.
William Tate.

Skurray, Thomas,

Abingdon, Berkshire.

Brewer's Chemist. University College, London, session 1886—87; since then General Brewing and Aerated Water Chemistry.

Charles Graham.
John Heron.
John Hughes.
William Odling.
B. E. R. Newlands.
Walter Palmer.
John A. R. Newlands.
R. A. Bush.
Basil Wm. Valentin.

Smith, Geo. P. Darnell,

26, Colebrooke Row, Islington, N.

Teaching. B.Sc., Lond. (Chemistry, Zoology, and Botany);

Student at University College, Gower Street, $2\frac{1}{2}$ years; Teaching, $1\frac{1}{2}$ years (Chemistry); Assistant in Soap Works, nine months.

William Ramsay. J. Norman Collie. R. T. Plimpton.
C. F. Baker. Harold Picton.

Spray, Henry John,

15, Bucharest Road, Wandsworth, S.W.

Work's Chemist. Student at the Technical College, Finsbury, evening sessions, 1885—6, 1888—9; two years pupil to Mr. W. Fox, Analyst, Gt. Tower St., E.C.; two years Chemist to Messrs. W. Houlder, Son, and Co., Chemical Manufacturers, Southall, Middlesex; six months Chemist to the Electrical Power Storage Co., Millwall; two years Assistant Chemist to Messrs. Hopkin and Williams.

John Hodgkin. David Howard.
Alfred G. Howard. J. Lloyd Howard.
H. Livingstone Sulman.

Squires, Alfred James,

16, Lower Sleaford Road, Newark, Notts.

Analytical (Works) Chemist. Formerly Assistant to the late Dr. Voelcker, F.R.S. Late Assistant in the Laboratory of the "Royal Agricultural Society." Now of Quibell Bros., Manure Manufacturers, Newark.

J. Augustus Voelcker. E. W. Voelcker.
Thos. Howard. William H. Martin.
Oliver Quibell. Alfred H. Allen.
Bernard Dyer.

Sykes, James,

76, Lockwood Road, Huddersfield.

Assistant in the Laboratory of Public Analyst. Assistant in Laboratory of Public Analyst for the County Borough of Huddersfield; assistant teacher of the evening Chemistry Classes at the Huddersfield Technical School.

Austin Keen. Joe Frost.
L. Gordon Paul. Lewis S. Cocking.
Frederick W. De Velling. *James Robt. Kaye.*
C. Rawson.

Trewers, Morris William,

2, Phillimore Gardens, Kensington, W.

Chemical Student, University College, London; $2\frac{1}{2}$ years student at University College, London.

William Ramsay. John Norman Collie.
R. T. Plimpton. C. F. Baker.
C. W. Heaton.

Woods, Hugh,

11, Archway Road, Highgate, N.

Doctor of Medicine. M.D., B.S., M.A.O., B.A. (Dublin). Senior Moderator in Experimental Science (Dublin). Medical scholar (1884—86) in Chemistry, Physics, &c. (Dublin).

J. Emerson Reynolds.	A. H. McConnell.
Augustus E. Dixon.	*C. Tomlinson.*

E. H. Gaskell.

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Issued 27/2/1892.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

No. 107. Session 1891–92.

February 18th, 1892. Professor W. A. Tilden, F.R.S., Vice-President, in the Chair.

It was announced that the following changes in the Council were proposed by the Council:—

As Vice-Presidents: Mr. A. Vernon Harcourt, F.R.S., and Professor W. Ramsay, F.R.S., *vice* Professors G. Carey Foster, F.R.S., and J. Emerson Reynolds, M.D., F.R.S.

As ordinary members of Council: Professor Harold Dixon and Messrs. R. J. Friswell, John Heron and W. P. Wynne, *vice* Dr. E. Atkinson. Professor E. Kinch, Mr. Boverton Redwood and Professor Thomas Purdie.

Messrs. Holland Crompton, Bernard Dyer and T. S. Dymond were appointed to audit the Society's accounts.

Certificates were read for the first time in favour of Messrs. Alexander Barratt, Bronhenlog, Mostyn, N. Wales; Frank Comyns, B.A., 55, South Street, Durham; Joseph Davies, 28, Robarts Road, Anfield, near Liverpool; James C. Frazer, Victoria Square, Adelaide, South Australia; John Theodore Hewitt, St. John's College, Cambridge; William James McKerrow, care of Hall, McKerrow & Co., Nicholas Street, Manchester; George Harry Major, Coldstream Street, Llanelly; Reginald Edensor Stanley Richardson, Elmfield, Knighton. Leicester; Thomas Shortridge Tweedie, The Moat, Annan; George Isaac James Wells, F.I.C., Kinderton Lodge, Middlewick, Cheshire.

The following were duly elected Fellows of the Society:—Arthur Adams; Frederick Edward Adams; Frederick Fielding Bond;

William John Atkinson Butterfield; Hugh Brown Collins, B.Sc., C.E.; Francis V. Darbishire; Robert Brooke Floris; Alfred Thomas Gailleton; William Percy Hatton; James Hendrick; John C. Hewlett; Lionel Manfred Jones; Albert Henry Luckett; William Cossar Mackenzie; John Edward Whitley McFall; Charles Stephen Meacham; James Hill Millar; Robert Ludwig Mond; William Shields Myers; William Pullinger; Ernest John Parry; Charles Frederick Seymour Rothwell; Thomas John Buckler Sandercock; James Alexander Schofield; Thomas Skurray; George P. Darnell Smith; Henry John Spray; Alfred James Squires; James Sykes; Morris William Trewers; Hugh Woods.

The following papers were read:—

108. "A search for a cellulose-dissolving (cytohydrolytic) enzyme in the digestive tract of certain grain-feeding animals." By Horace T. Brown, F.R.S.

The author, in a recent paper by himself and G. H. Morris (*C.S. Trans.*, 1890, 459), has shown that during germination of the seeds of the grasses the cell-membrane of the endosperm is broken down and destroyed by a specific cellulose-dissolving enzyme, or *cytohydrolyst;* and that the breaking down of the cell-wall is a necessary preliminary to the dissolution of the reserve starch and proteids of the cell-contents, which otherwise would not readily come under the influence of the extremely indiffusible starch and proteid-dissolving enzymes secreted by a certain layer of cells in the embryo.

As it was found by the author that the analogous starch-hydrolysing enzyme of animal saliva and of the pancreatic secretion experiences the same difficulty in traversing the thin cell-membrane, it appeared almost certain that in grain-feeding animals there must be some provision in their economy for removing, during the processes of digestion, the inverting cell-membrane of the starch-containing cells of the interior of the grain, and of thus bringing the cell-contents fully under the influence of the digestive enzymes of the alimentary canal.

An examination of the contents of the small intestine of a pig, fed a few hours before death with barley-meal, conclusively showed that by the time the food had reached this point the originally intact parenchymatous cell-walls of the grain had undergone almost complete dissolution, and that the starchy and proteid cell-contents had been completely freed from their cell-envelopes and were being rapidly dissolved under the influence of the pancreatic secretion.

As the phenomena were in the highest degree suggestive of the cell-wall being dissolved by an enzyme, the search for this cytohydrolyst was commenced by a very full examination of the *pancreas*, that of the *pig*, *horse*, *ox* and *sheep* being employed, but not the slightest evidence could be obtained that this organ is capable of secreting an enzyme having any action on cellulose.

A continuance of the search in the small intestine itself, which is known to possess certain hydrolysing functions, was rendered unnecessary when it was discovered that the action on the cell-wall of the grain food has already taken place before the stomach-contents have passed into the small intestine. It was, therefore, in the stomach itself, or in the salivary glands, that the search had to be continued; but the enquiry was further narrowed by the fact that animal saliva was found to be incapable of exercising any action on cellulose.

The experiments on the stomach-membrane and stomach-contents were all made on the *horse* and the *pig*. The dissolution of the vegetable cell-membrane in the stomach may be due to one or more of the following causes, viz.:—

(1.) To mechanical disintegration brought about by the "churning" and "propulsive" movements of the stomach during digestion.

(2.) To the action of the natural acids of the stomach, which may bring about the dissolution of the cellulose either (*a*) by direct hydrolysis, or (*b*) by converting a zymogen of the grain into an active cytohydrolyst.

(3.) To the action of a special enzyme secreted by some portion of the mucous membrane of the stomach.

(4.) To the direct or indirect action of living *micro-organisms*. These may break down the cell-wall by:—

- (*a*.) A direct attack of the living organism without the intervention of a secreted enzyme.
- (*b*.) A previous secretion by the organism of a special cytohydrolyst.
- (*c*.) An indirect production of a cytohydrolyst by the modification of some of the constituents of the grain by the vital processes of the micro-organisms.

(5.) To the self-digestion of the food under the influence of a cytohydrolyst pre-existent in the grain before ingestion.

Each one of these possible cases had to be examined separately in order to determine the *vera causa* for the destruction of the parenchymatous cell-wall which undoubtedly takes place in the stomach during digestion. It is shown by numerous experiments that the destruction of the membrane is not due to mechanical disintegration nor yet to any action of the stomach-acids, nor is it attributable to the direct or indirect influence of micro-organisms. The cell-wall is, undoubtedly, dissolved by a cytohydrolytic enzyme; but, contrary to what was expected, this enzyme is not secreted by any portion of the mucous membrane of the stomach, but is pre-existent in the grain before ingestion, the animal itself contributing nothing to the result except by affording suitable conditions of temperature, &c., for the action of the enzyme.

In a previous paper by the author and G. H. Morris (*loc. cit.*) it was stated that the cellulose-dissolving enzyme which is of so much indirect importance to the plantlet during the germination of the seeds of the grasses is not pre-existent in the seed during its resting stage, but is a product of the germinative processes. Although this is strictly true as regards the morphologically perfect and highly-matured barley which was used during the greater part of that research, it is not strictly true of all barley or grasses, especially of barley grown in this country under somewhat imperfect climatic conditions. This, as a rule, contains, even in its resting state, more or less of the cellulose-dissolving enzyme, and the same is true as regards *rye.* In *oats* the cytohydrolyst is particularly abundant, and this fact explains the very great rapidity with which the endosperm of the oat is disintegrated in the early stages of digestion in the horse as observed by the author, and also throws considerable light on the cause of the high estimation in which oats are held as a food-stuff.

That the dissolution of the cell-membrane is due wholly and entirely to the cytohydrolyst of the food-stuff was proved by making a parallel series of experiments on animals fed in the one case with barley-meal which was destitute of cytohydrolysing power, and in the other case with the same meal to which a small amount of germinated grain had been previously added. In the first instance no destruction of the parenchymatous cell-wall took place in the animal's stomach; whilst in the second case the vegetable membrane was completely dissolved in a very short time.

The presence of a cytohydrolyst and its amount in the food of grain-feeding animals is a factor, and, perhaps, a very important one, in their nutrition, for the more or less complete preliminary preparation of the food in the stomach before it passes into the intestine cannot be a matter of indifference to the animal physiologically.

The experiments have a very important bearing on the lengthy investigation carried out at Rothamsted, some years ago, on the relative value of malted and unmalted grain as a food for stock. The whole of the subject requires re-examination from a new point of view, and it does not seem at all unlikely that the supposed condimental value of malt, which has been insisted on by many agriculturists in the face of the Rothamsted experiments, may, after all, be a fact.

DISCUSSION.

Mr. BROWN, in reply to Professor Tilden, said that the enzyme in question was undoubtedly distinct from diastase and unable to attack starch. With reference to the question put by Professor Green, whether the cæcum of herbivora was not the seat of the digestion of the cellulose in the major portion of their food, he thought that it was clearly shown by Tappeiner's experiments that this was the case, and that its digestion was effected through the agency of micro-organisms. He was unable at present to give any reply to Mr. Cross's question as to the behaviour of the different varieties of cellulose.

109. "On the influence of oxygen and concentration on fermentation." By Adrian J. Brown.

The author describes experiments on the reproductive power of yeast, from which it appears that all fermentable nutritive solutions encourage the increase in number of yeast cells to some fixed point beyond which they will not reproduce themselves; and he shows that if a greater number of cells be introduced into a fermentable liquid than the liquid could originally develop, no increase in number of cells takes place. As under conditions like these fermentation still proceeds vigorously, a number of disturbing factors which complicate the results obtained under ordinary conditions may be eliminated by using non-multiplying yeast cells.

A series of experiments are described in which fermentations were conducted in presence of large amounts of oxygen, whilst at the same time duplicate experiments were made in which oxygen was excluded: the same number of non-multiplying yeast cells being used in both cases, and all the other conditions, such as temperature and agitation, &c., being kept constant. Under these circumstances it was found that both equal numbers of yeast cells and equal weights in presence of oxygen exercised more fermentative power than when unexposed to its influence. The author is unable to reconcile these results with M. Pasteur's theory of fermentation.

Experiments carried out with a fixed number of non-increasing yeast cells also showed that the amount of sugar fermented in a given time by them did not depend on the concentration of the solution, but that within the limits of 20 and 5 per cent. solutions of dextrose, approximately the same weight of sugar was fermented. When the strength of a solution reaches 30 per cent. of dextrose fermentation proceeds much more slowly.

110. "Limettin." By William A. Tilden, D.Sc., F.R.S.

Limettin is the name given by the author to a crystalline substance deposited from the essential oil of the lime, originally described by him in conjunction with C. R. Beck (*C.S. Trans.*, 1890, 323).

Further investigation of its properties shows that, instead of the formula $C_{16}H_{14}O_6$ first attributed to it, limettin has the composition expressed by the molecular formula $C_{11}H_{10}O_4$, which requires nearly the same percentages of carbon and hydrogen.

By the action of nitric acid it is converted into a nitro-derivative $C_{11}H_9(NO_2)O_4$, and by the action of bromine into a dibromo-derivative $C_{11}H_8Br_2O_4$, while chlorine converts it into a trichloro-compound $C_{11}H_7Cl_3O_4$. The dibromo-compound also exchanges the third atom of hydrogen for chlorine, giving $C_{11}H_7Br_2ClO_4$. Oxidising agents convert limettin into acetic or oxalic acid without definite intermediate products. Potash fusion produces from it phloroglucol and acetic, but no other acid. Treatment with concentrated solution of hydrogen iodide causes the elimination of two methyl groups.

Sulphuric acid slightly diluted causes limettin to assimilate a molecule of water forming a phenolic compound of which the diacetate was prepared and analysed.

Limettin is not attacked by acetyl chloride, by phenylhydrazine or by sodium amalgam, and it gives no coloration with ferric chloride. It forms very pale-yellow, thin prisms, which melt at 147·5; it dissolves in alcohol, benzene, toluene and acetic acid pretty freely, but scarcely in water or in light petroleum. Dilute solutions exhibit a beautiful violet fluorescence. It seems to have the constitution $C_6H_3(OCH_3)_2{\cdot}C_3HO_2$. Further experiments are in progress.

111. "The acid action of drawing papers." By C. Beadle.

Professor W. N. Hartley has recently communicated a note on this subject (these Proceedings, 1892, 19) which raises questions of considerable technical importance. The fact of the "acidity" of papers need not be discussed, and Professor Hartley's contention that an acid constituent in the paper has a serious effect on "water colours" applied to the paper I am not in a position to criticise. I merely wish to point out that the author is probably in error as to the *cause* of the acidity, which he takes to be a residue of sulphuric acid left in the "fibre" (rags) after the process of "souring" and washing.

The mill where the "Whatman" papers are made is situated at Maidstone, and the water used in the manufacture is the characteristically hard water of that district. The "souring" of the rags is followed by a long process of continuous washing in the "engine," and after some years' experience of paper making in the Kentish district I am satisfied that no acid can survive this treatment.

On the other hand, the papers are sized with gelatin and alum, and it is to the presence of the latter constituent that the "acidity" is, in my opinion, due. In a recent examination of one of these papers I obtained, by treating with distilled water, an exhaust which showed "acidity" equal to 2·3 c.c. normal H_2SO_4 per 100 grams paper, *using litmus* as indicator in the titration, and yet this exhaust was *basic to methyl orange*. Sulphate of alumina, $Al_2,3SO_4$, being acid to methyl orange, the evidence is complete that the apparent "acidity" of the aqueous exhaust is due to the presence of a basic sulphate of alumina (*cf. Jour. Soc. Chem. Ind.*, 1891, 202).

ADDITIONS TO THE LIBRARY.

I. *Donations.*

A Treatise on Chemistry, by H. E. Roscoe and C. Schorlemmer. Vol. III. Part VI. London 1892. From the Authors.

Lac Ingol; Recherches Medico-topographo-chimiques, par S. S. Zaleski. Tomsk 1891. From the Author.

U.S. Geological Survey:—

Tenth Annual Report, 1888–89, by J. W. Powell; Part 1, Geology; Part 2, Irrigation. Washington 1890.

Bulletin. Nos. 62, 65, and 67–81. Washington 1890–91.

From the Director of the Survey.

II. *By Purchase.*

Anorganische Chemie, von F. Krafft. Leipzig und Wien 1891.

Methods of Gas Analysis, by W. Hempel. Translated from the 2nd German Edition by L. M. Dennis. London 1892.

The Chemistry of Iron and Steel Making, by W. Mattieu Williams. London 1890.

Engineering Chemistry, by H. J. Phillips. London 1891.

A System of Inorganic Chemistry, by W. Ramsay. London 1891.

Solutions, by W. Ostwald. Translated from the 2nd edition of Ostwald's Lehrbuch der allgemeinen Chemie, by M. M. P. Muir. London 1891.

Fremy's Encylopédie chimique. Tome III, 13 cahier, 2 partie: Plomb et ses composés, par F. Parmentier. Tome V, 2 section, 2 partie. L'Or, par E. Cumenge et E. Fuchs. Paris 1892.

Chemische Technologie der Gespinnstfasern, von O. N. Witt. Lief. 1 und 2. Braunschweig 1888 und 1891.

ANNIVERSARY MEETING AND SECOND ANNIVERSARY DINNER.

The Anniversary Meeting will be held at *Four o'clock in the Afternoon* of Wednesday, March 30th next.

It is arranged that on the evening of the same day the Fellows and their friends will dine together at the Whitehall Rooms, Hôtel Métropole.

At the next meeting, on March 3rd, the following papers will be read:—

"A rule for determining whether a given benzene mono-derivative shall give a meta-di-derivative or a mixture of ortho- and para-di-derivatives." By Professor Crum Brown and Dr. Gibson.

"The relative orienting effect of chlorine and bromine." By Dr. Armstrong and Mr. Briggs.

"Contributions to our knowledge of the aconite alkaloids.

"Part II. The alkaloids of true *Aconitum napellus*." By Professor Dunstan and Mr. Umney.

"Part III. The properties of aconine. Conversion of aconine into aconitine." By Professor Dunstan and Dr. Passmore.

"Note on the origin of the luminosity of coal-gas flames." By Wm. Foster, M.A.

"The volumetric estimation of mercury." By Chapman Jones.

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PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

No. 108. Session 1891–92.

March 3rd, 1892. Professor A. Crum Brown, F.R.S., President, in the Chair.

Messrs. G. P. Darnell Smith, Ernest J. Parry, Robert Ludwig Mond, W. P. Hatton and W. J. A. Butterfield were formally admittted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. George Price Dodds, 3, Eversley Place, Heaton, Newcastle-on-Tyne; Henry Ellison, Whitechapel Road, Cleckheaton; Albert Augustus Lintern, High School, Middlesbrough; Herbert Edward Lindley, 13, St. Bartholomew Road, Camden Road, N.; John Northing, 96, Tretonville Road, Sandymount, Co. Dublin; Frederick J. Oldershaw, 34, Bramhall Lane, Stockport; Albert Ernest Richardson, 4, Black Hall Road, Oxford; James Stenhouse, Tanfield, Inverleith Row, Edinburgh.

Address to Professor Bunsen.

It was announced that it was proposed to present the following address to Professor Bunsen, who has now been fifty years a Foreign Member of the Society, and that among those who sign it all those who have been his pupils should, as far as possible, be included :—

To Privy Councillor Professor Bunsen, Fellow of the Royal Society.

YOUR EXCELLENCY,

Fifty years have elapsed since the Chemical Society of London honoured itself by electing you one of its Foreign Members. Your name, and that of your illustrious fellow-countryman Liebig, are, in fact, first on a list which includes the most distinguished cultivators of chemical science in every civilised country of the world.

Our Society remembers with gratitude that you enriched the first volume of its Transactions by communicating to it the results of your ever-memorable investigation of Cacodyl and its compounds. That you should have sent to us, in the first and most critical year of our existence, a memoir which the chemical world will ever regard as one of the classics of our science, is a significant proof of the beneficent interest with which you regarded our efforts to foster the growth of chemical learning in this country.

Your masterly investigations, in collaboration with our Fellow Sir Lyon Playfair, on the gases evolved from iron furnaces, made by methods which you were the first to bring to perfection, greatly extended our knowledge of the theory of the smelting of iron. By the permanent benefit thus conferred on one of the most important of our industries, you have largely augmented our national wealth.

The half century during which you have been associated with our Society has been fruitful in great discoveries and important inventions. It has witnessed the birth of new elements, the creation of new analytical methods, and an extraordinary development in the instrumental resources of our laboratories. Chemists will never forget that it is to your unwearied assiduity and single-minded devotion that science owes some of the most momentous of these discoveries, and some of the most valuable of these inventions. Your investigations will ever be regarded as models of the highest type of scientific research, and the memoirs in which you have embodied them shed an imperishable lustre on our literature. Your methods of analysis are among the most common of our manipulative operations, and the very furniture and instruments of our laboratories are an ever-present testimony to the obligations under which experimental chemistry will always remain to you.

Many of our members are proud to be numbered among your pupils, and those among them who have become teachers have, we trust, caught and transmitted something, not only of the method, but also of the spirit, in which they themselves were taught. They have an abiding memory of your kindliness, of your constant and unselfish devotion to their interests, and of the generous sympathy and ready help which you extended to their efforts to enlarge the boundaries of our science.

We, the undersigned Fellows of the Chemical Society of London, now beg to offer you our heartfelt felicitations on the occasion of your Jubilee as a member of our body. It is our fervent hope that you may be able, for many years to come, to enjoy in health and happiness the leisure and repose which you have so justly and so honourably earned.

Fellows of the Society who have been pupils of Professor Bunsen are requested to communicate with the Senior Secretary before March 19, in order that they may receive a form for signature.

Of the following papers, those marked * were read :—

*112. "A rule for determining whether a given benzene monoderivative shall give a meta-di-derivative or a mixture of ortho- and para-di-derivatives." By Professor Crum Brown and Dr. Gibson.

The rule suggested will be understood after reference to the following table :—

A.	B.	C.	D.	E.
C_6H_5Cl	$\cdot Cl$	HCl*	$HOCl$	*o-p.*
C_6H_5Br	$\cdot Br$	HBr*	$HOBr$	*o-p.*
$C_6H_5CH_3$	$\cdot CH_3$	HCH_3*	$HOCH_3$	*o-p.*
$C_6H_5NH_2$	$\cdot NH_2$	HNH_2*	$HONH_2$	*o-p.*
C_6H_5OH	$\cdot OH$	HOH*	$HO\cdot OH$	*o-p.*
$C_6H_5NO_2$	$\cdot NO_2$	HNO_2	$HO\cdot NO_2$*	*m.*
$C_6H_5CCl_3$	$\cdot CCl_3$	$HCCl_3$*	$HO\cdot CCl_3$	*o-p.*
$C_6H_5CO\cdot H$	$\cdot CO\cdot H$	$HCO\cdot H$	$HO\cdot CO\cdot H$*	*m.*
$C_6H_5CO\cdot OH$	$\cdot CO\cdot OH$	$H\cdot CO\cdot OH$	$HO\cdot CO\cdot OH$*	*m.*
$C_6H_5SO_2\cdot OH$	$\cdot SO_2\cdot OH$	$HSO_2\cdot OH$	$HO\cdot SO_2\cdot OH$*	*m.*
$C_6H_5CO\cdot CH_3$	$\cdot CO\cdot CH_3$	$HCO\cdot CH_3$	$H\cdot CO\cdot CH_3$*	*m.*
$C_6H_5CH_2\cdot CO\cdot OH$	$\cdot CH_2\cdot CO\cdot OH$	$H\cdot CH_2\cdot CO\cdot OH$*	$HO\cdot CH_2\cdot CO\cdot OH$	*o-p.*

It will be seen that whenever the *hydride* of the radicle (column C) contained in the mono-derivative (column A) is asterisked, column E shows that a mixture of ortho- and para-di-derivatives is formed, and that whenever the *hydroxide* of the radicle (column D) contained in the mono-derivative (column A) is asterisked, column E shows that the meta-derivative is obtained.

The substances marked with an asterisk in column C are such hydrides as are *not* convertible by *direct* oxidation into the corresponding hydroxides in the next column, whereas those asterisked in column D are compounds which can be formed by direct oxidation from the corresponding hydrides; the rule is based on this distinction.

DISCUSSION.

Mr. GROVES having referred to the statement which was on record that hydrogen chloride was oxidisable to hypochlorite by permanganate,

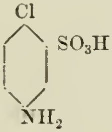
Professor THORPE said that this was an error, and arose from the use of impure permanganate, made by the old-fashioned method with the aid of chlorate.

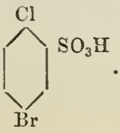
Dr. Armstrong remarked that the rule suggested might be regarded as a modification of the usual statement that derivatives containing *acid* radicles gave meta-derivatives, since not only NO_2, SO_3H, CO_2H, but also COH and COR, might be ranked as acid radicles. In neither form, however, did the rule apply to such a case as that afforded by dimethylaniline, which yields much meta-derivative.

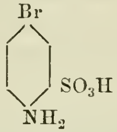
*113. " The relative orienting effect of chlorine and bromine. (I.) The constitution of parabrom- and parachlor-anilinesulphonic acids." By Henry E. Armstrong and J. F. Briggs.

The case studied is that afforded by parachlorobromobenzene : it is found that when sulphonated this yields an uniform product characterised by a sulphochloride melting at 66°, which crystallises in massive, prismatic plates very similar to paradibromobenzene sulphochloride, the corresponding amide melting at about 178° (uncorr.).

To determine the constitution of this product, the amido-acids prepared by sulphonating parabromaniline and parachloraniline were converted into chlorobromobenzenesulphonic acids; they gave isomeric acids, as should be the case if they were of corresponding constitution, the acid prepared from parachloranilinesulphonic acid being identical with the product from chlorobromobenzene.

According to Claus and Mann (*Annalen*, **265**, 92), parachloraniline yields two isomeric acids on sulphonation, one being formed in but small quantity. The authors have been able to obtain only one acid : they have, indeed, observed that no fewer than three distinct forms of crystals separate from the aqueous solution of the product—long, striated rods springing from a common centre ; rectangular, apparently rhombic prisms ; and rhombs, probably monoclinic, which rapidly become opaque on exposure to air : but these appear to be all one substance, the difference in form being conditioned by difference in the amount of water of crystallisation. Claus has assigned the formula  to the acid. This is confirmed by the authors, who find that, on displacing the NH_2 by hydrogen by the hydrazine method, the acid yields chlorobenzene*ortho*sulphonic acid.

Hence it follows that the acid formed by sulphonating parachlorobromobenzene is . It would seem, therefore, that the chlorine rather than the bromine "attracts" the sulphonic group; but it will be necessary to ascertain whether the isomeric acid is not perhaps a less stable form, in which case it may be that the final product is not merely the product of direct sulphonation.

The chlorobromo-acid prepared from parabromanilinesulphonic acid yields a sulphochloride crystallising in ill-defined plates melting at 46°, the corresponding amide melting at about 191° (uncorr.); the fact that it is different from the chlorobromo-acid prepared from parachloranilinesulphonic acid is in itself conclusive evidence that the acid obtained from parabromaniline is not 

, as Borns asserts, but that it corresponds in constitution to the acid prepared from parachloraniline, as might indeed be expected to be the case. Borns (*Annalen*, **187**, 372) bases his conclusion as to the constitution of the acid on its conversion by displacement of the NH_2 group by hydrogen into bromobenzene*meta*sulphonic acid, but no proof that he was dealing with this and not the ortho-acid is given beyond that contained in the bare statement that his product was recognised as the meta-acid from the composition and properties of the potassium and barium salts, the chloride (oily) and amide (m. p. 154°). The bromosulpho-acid obtained by the authors, however, yields an amide melting at about 183°, and is, undoubtedly, the ortho-acid. Parabromanilinesulphonic acid crystallises in three distinct forms closely resembling those in which the parachloro-acid crystallises.

DISCUSSION.

The PRESIDENT remarked that it was usually supposed that NH_2, like OH, had a powerful directing influence, and therefore it appeared remarkable that para-brom- and chlor-aniline should yield sulphonic acids in the formation of which this influence of the NH_2 group apparently did not come into play.

Dr. ARMSTRONG, in reply, said he thought it probable that in consequence of the formation of sulphate, the NH_2-group was rendered ineffective, and as the para-position is blocked by it, necessarily an ortho-chloro- or bromo-sulphonic acid was formed.

*114. "Note on anhydrides of sulphonic acids." By Henry E. Armstrong.

Hitherto but little attention has been paid to this class of compounds: not long after Hübner, in 1884 (*Annalen*, **223**, 238), had described a series of somewhat unsuccessful attempts to prepare phenylsulphonic anhydride, Abrahall succeeded in obtaining this compound by interaction of phenylsulphonic chloride and silver phenylsulphonate (*cf. C.S. Trans.*, 1886, 692); he describes it as crystallising from chloroform in fine prisms melting at 54°, and as being extremely deliquescent. Meanwhile it had been observed in Victor Meyer's laboratory that a number of bromo- and chloro-derivatives of thiophen, as well as paradibromobenzene and 1 : 2 : 4-tribromobenzene, gave sulphonic anhydrides directly on treatment with pyrosulphuric acid, all the anhydrides thus obtained being remarkable on account of their very slight solubility, even in boiling water, and the difficulty with which they were hydrolysed (*cf. Berichte*, 1886, 652).

In the course of the experiments with parachlorobromobenzene, referred to in the previous abstract, it was noticed that whereas this was wholly converted into sulphonic acid by so-called 100 per cent. acid, a fuming acid containing about 20 per cent. of anhydride gave as chief product a microcrystalline anhydride similar to that prepared by Rosenberg from paradibromobenzene. On contrasting the behaviour of paradichloro-, chlorobromo- and dibromo-benzenes with such fuming acid, it was found that the dichloro- gave relatively the smallest, and the dibromo-derivative the largest, yield of anhydride, monochlorobenzene yielding only sulphonic acid and sulphone. It therefore seemed probable that the anhydride was a secondary product formed by dehydration of the sulphonic acid under the influence of the sulphuric anhydride: and that this is the case is shown by the fact that if, for example, potassium dibromobenzenesulphonate be mixed with fuming sulphuric acid, it is converted into the corresponding anhydride. To judge from a statement made by Bässmann (*Annalen*, **191**, 213), it would seem that, in some cases, such anhydrides may be precipitable even from aqueous solutions of sulphonates. Obviously there are the same differences between sulphonic acids as between carboxylic acids with regard to the readiness with which they undergo dehydration.

*115. "Contributions to the knowledge of the aconite alkaloids. Part II. The alkaloids of true *Aconitum napellus*." By Professor Dunstan and Mr. John C. Umney.

The authors have examined the alkaloids of true *Aconitum napellus* plants grown by Mr. E. M. Holmes at the instance of the British Pharmaceutical Conference. The alkaloids were extracted from the roots by the following process, which precludes the possibility of the occurrence of hydrolysis, &c.:—The solution obtained by percolating with cold rectified fusel oil (b. p. 100—132°) was agitated with water acidified with 1 per cent. of sulphuric acid, and the resin having been removed by extracting the acid solution so obtained with chloroform, the liquid was made just alkaline with dilute ammonia and extracted with ether, which dissolved out a considerable quantity of alkaloid, but left in solution a further and smaller quantity, which was subsequently extracted by agitation with chloroform. The *alkaloid soluble in ether* was obtained as a gum-like mass incapable of crystallisation. By conversion into bromhydride it was separated into a crystallisable and an uncrystallisable salt.

The crystalline product was identified as the salt of aconitine, the crystalline and highly toxic alkaloid already described by one of the authors and Dr. W. H. Ince (*C.S. Trans.*, 1891). The alkaloid separated from the pure bromhydride melted at 188·5° (corr.), and afforded on combustion numbers agreeing with the formula $C_{33}H_{45}NO_{12}$. The specific rotation of the bromhydride in aqueous solution was ascertained to be $[\alpha]_D$ $-29{\cdot}65$, a value which agrees with that previously recorded. As some doubt exists as to the solubility of aconitine in water, a determination was carefully made with this pure specimen. The mean of two determinations gave 1 gram in 4431 grams of water as the solubility at 22°; Jürgens had previously recorded the far greater solubility of 1 in 745 at the same temperature.

The non-crystalline bromhydride furnished a gummy alkaloid soluble in ether and alcohol, but only sparingly soluble in water, the aqueous solution being alkaline to litmus, and very bitter, but not giving rise to the tingling sensation so characteristic of aconitine. Not only the alkaloid, but also the chlorhydride, sulphate, nitrate and aurichloride prepared from it could not be crystallised. This alkaloid is not identical either with aconine or with the picraconitine of Wright and Luff. A full account of it will be given in a later paper, considerable progress having already been made in the most difficult task of isolating it in a pure state. The authors propose to assign to it the name *napelline*, which was first given to the alkaloid now known as pseudaconitine, and afterwards by Hübschmann to a substance which the work of Wright and Luff showed to be a mixture chiefly composed of aconine. The napelline obtained in the manner described is probably associated with another amorphous alkaloid about which they have at present little information to give beyond the fact that neither it nor its salts appear to crystallise.

The *alkaloid soluble in chloroform* was proved to be *aconine*, the compound which is obtained together with benzoic acid on hydrolysing aconitine.

The roots of true *Aconitum napellus*, therefore, must be held to contain three alkaloids, one of which is crystalline, viz., aconitine, two being amorphous, viz., napelline and aconine. Indications have been obtained of the presence of a fourth alkaloid, which is amorphous and closely resembles napelline.

The authors find that the juice expressed from the roots contains a large proportion of amorphous bases but very little aconitine, the greater part of this latter remaining in the root, from which it may be extracted, together with the remainder of the amorphous alkaloids, by exhausting with amyl alcohol. The total quantity of amorphous alkaloid obtained amounted to more than twice that of aconitine.

The physiological action of the alkaloids referred to is being investigated. The results so far obtained point to the conclusion that crystalline aconitine is by far the most toxic of the alkaloids contained in *Aconitum napellus.*

*116. "Contributions to our knowledge of the aconite alkaloids. Part III. The formation and properties of aconine and its conversion into aconitine." By Professor W. R. Dunstan and Dr. F. W. Passmore.

Owing to the uncertainty which exists with reference to the product of the hydrolysis of aconitine, the authors have re-investigated the subject, using a pure alkaloid. Wright and Luff have stated that when aconitine is hydrolysed the sole products are aconine and benzoic acid. More recently, however, Dragendorff and Jürgens have asserted that the hydrolysis occurs in two stages, their contention being that benzoic acid and an alkaloid identical with the picraconitine isolated by Wright and Luff from the roots of supposed *Aconitum napellus* are formed in the first stage, while in the second stage the picraconitine is hydrolysed into benzoic acid, methyl alcohol and aconine, which last is the final product of hydrolysis.

The authors have carefully hydrolysed pure aconitine by heating it with water in closed tubes at 150°, but have been unable to obtain at any stage either picraconitine or methyl alcohol. The alkaloid extracted from the solution by ether was proved to be a mixture of aconine with unaltered aconitine. Using pure aconitine, action occurs precisely in accordance with the equation $C_{33}H_{45}NO_{12} + H_2O = C_{26}H_{41}NO_{11} + C_7H_6O_2$, leaving little doubt that aconitine is benzoylaconine.

Although attempts to establish the correctness of this inference by heating aconine with benzoic anhydride were without result, anhydroaconitine was eventually obtained by the interaction of aconine and ethylic benzoate at 130°: as the anhydro-compound is convertible into aconitine, the partial synthesis of the alkaloid thus effected leaves no doubt that it is benzoylaconine.

Up to the present time, neither aconine nor its salts have been obtained in a crystalline state. The authors have hitherto been unsuccessful in all their attempts to crystallise aconine, but they have succeeded in crystallising several of its salts, viz., the chlorhydride, bromhydride, sulphate and nitrate. All these salts are very soluble in water, the chlorhydride being least soluble and the easiest to crystallise: it is best prepared by crystallisation from a mixture of alcohol and ether; when dried at 100° it melts at 175·5° (corr.). The crystals deposited from alcohol have the composition $C_{26}H_{11}NO_{11},HCl,2H_2O$. When dried at 100° they still retain one molecular proportion of water, which is, however, lost at 120°. The aqueous solution is lævorotatory: $[\alpha]_D = -7{\cdot}71°$. It combines with auric chloride forming an aurichloride considerably more soluble than the corresponding aconitine salt.

Aconine was prepared from the pure chlorhydride by adding silver sulphate and subsequent treatment of the aconine sulphate with exactly sufficient baryta water. The solution on evaporation furnished a hygroscopic, brittle gum which refused to crystallise; this melted at 132° (corr.), and on analysis it afforded numbers agreeing with the formula $C_{26}H_{41}NO_{11}$, which is that proposed by Dunstan and Ince from the results of their study of pure aconitine. Aconine is very soluble in water; the aqueous solution is alkaline. When dry it is insoluble in ether and almost insoluble in chloroform. It is a powerful reducing agent, precipitating the metals from solutions of gold and silver salts; it also reduces Fehling's solution. The physiological action of pure aconine is being investigated. Its aqueous solution is slightly bitter and gives rise to a burning sensation in the mouth, but does not produce the tingling which is characteristic of aconitine. In respect of its action on polarised light aconine exhibits the same peculiarity as aconitine. Its salts are lævorotatory, whilst a solution of the alkaloid is dextrorotatory, $[\alpha]_D +23°$. When heated with alkalis aconine slowly resinifies.

The examination of various agents on aconine has so far not led to any important results. Nitrous acid fails to attack it. The principal product of its oxidation by alkaline permanganate is oxalic acid. Attempts to isolate an additive compound with methyl iodide have been unsuccessful.

By the action of methyl iodide on aconitine a crystalline *aconitine methiodide* ($C_{33}H_{45}NO_{12}{\cdot}CH_3I$) was obtained, which melts at 219° (corr.). The *aconitine methhydroxide* prepared from the compound ($C_{33}H_{45}NO_{12}{\cdot}CH_3OH$) is amorphous, and the salts which it yields do not appear to crystallise. A further study will be made of this compound, and its physiological action will be investigated.

At the conclusion of the paper Professor Dunstan exhibited and described a simple laboratory shaking appliance devised by Mr. Dymond and himself, an account of which is to be found in the *Pharmaceutical Journal* of March 5th, 1892.

DISCUSSION.

Mr. HOWARD said that the important conclusion now arrived at by the authors as to the nature of the alkaloids of pure *Aconitum napellus* illustrated the value of the botanist and chemist working together; it was to be expected that their cooperation would lead to other valuable results in the future, as the success achieved in increasing the yield of cinchona alkaloids would probably lead to progress being made in increasing the medicinal value of other plants.

Professor THORPE questioned the desirability of associating an old name with a new alkaloid.

The PRESIDENT expressed a similar opinion, citing the case of thiosulphate and hyposulphite in illustration of the confusion sometimes caused by such action.

Professor DUNSTAN, in his reply, said that the investigation had been made possible in the first instance only through the liberality of Mr. Howard, who gave them no less a quantity than an ounce of aconitine extracted by a known process from *A. napellus*. Napelline was a name which had been very little used, and it was very difficult to devise a better appellation for the new alkaloid.

*117. "Note on the carbon deposited from coal-gas flames." By Wm. Foster, M.A.

The author quotes analyses of cokes obtained by carbonising sugar and starch:—

	Carbon.	Hydrogen.
Cane-sugar coke—high temperature	95·0	1·1
,, ,, low ,, ...	94·1	1·2
Starch coke	95·0	0·9

From the similarity in composition of these cokes to that of the soot obtainable from coal-gas flames, he is of opinion that there is a resemblance in the general character of the chemical processes whereby they are formed.

*118. "The volumetric estimation of mercury." By Chapman Jones.

The author has found the cyanide method of estimating mercury suggested by Hannay (*C.S. Journ.*, 1873, 565) and modified by Tuson and Neison (*ibid.*, 1877, **32**, 679) to be unsatisfactory, the presence of carbon dioxide interfering with the titration. If, however, instead of adding the potassium cyanide solution until the turbidity produced by ammonia disappears, the titration be finished by adding, with certain precautions, a standard mercury solution until a definite and permanent turbidity is produced, concordant results are readily obtained. The method of working described is, if necessary, to separate the mercury as sulphide, and dissolve the washed precipitate in cold *aqua regia*, and to dilute and filter the solution. For the titration, litmus extract is added and neutralisation effected with solid potassium carbonate and hydrogen chloride, and finally with dilute ammonia. Excess of the cyanide solution is added, then a slight excess of ammonia, and, lastly, a standard solution of mercuric chloride, until a permanent turbidity is obtained, equal to that produced by 0·1 c.c. of the mercury solution in water containing about the same amounts of litmus and ammonia as the solution which is being titrated.

119. "Chromic acid." By Eleanor Field, Bathurst Student of Newnham College, Cambridge.

According to Moissan (*Ann. Chim. Phys.* [6], **5**, 568) it is possible to obtain crystals of the compound H_2CrO_4 by cooling with ice a solution saturated with CrO_3 at 90°. In the present notice, results are quoted which show that the crystals obtained on following Moissan's directions are but those of CrO_3.

The molecular weight of the dissolved substance calculated from the effect of CrO_3 on the boiling point of water was found to be only 57, which is far below the theoretical value, viz., $CrO_3 = 100·4$. Ostwald, from determinations of the lowering of the freezing point of water produced by CrO_3, came to the conclusion that the aqueous solution contains $H_2Cr_2O_7$ dissociated into three ions: by trebling the mean value deduced from the boiling point experiments, the value 171·85 is obtained, a number which does not agree either with the molecular weight of H_2CrO_4 (118·4) or with that of $H_2Cr_2O_7$ (218·8).

120. "The origin of acetylene in flames." By Professor V. B. Lewes.

The author has sought to determine whether acetylene is the product of high temperature change or of oxidation. The experiments described consisted in passing hydrocarbon gases and mixtures of such gases with others through a heated platinum tube 2 mm. in diameter, which, judging from experiments made to test the point, would seem to be without special action.

On passing methane alone through the tube while a length of

6 inches was heated to 1100° in the flat flame of a broad Bunsen, a product was obtained containing 3·2 per cent. of unsaturated hydrocarbons and 1·8 per cent. of acetylene. The effect of heating methane with other gases is indicated by the following figures:—

	3 per cent. oxygen.	15 per cent. air.	50 per cent. carbon monoxide.	60 per cent. hydrogen.
Unsaturated hydrocarbons.........	2·0	2·0	1·0	1·47
Acetylene.........	1·426	0·656	0·887	0·473
Carbon monoxide..	1·1	1·0	—	0·490

These results appear to point to acetylene being formed by the action of heat alone.

Ethane heated alone gave a product containing 19 47 per cent. unsaturated hydrocarbons and 3 224 per cent. of acetylene. The effect of heating ethane, diluted with 30 per cent. of hydrogen, with air was as follows:—

	15 p. c. air.	20 p. c. air.	25 p. c. air.
Unsaturated hydrocarbons.	7·69	5·58	5·05
Acetylene................	3·39	3·20	3·11
Carbon dioxide...........	0·00	1·01	1·51
,, monoxide.........	1·54	2·53	3·03

The effect of temperature on the formation of acetylene is well shown by the following results obtained on converting Russian petroleum into oil gas in a Patterson retort:—

Temperature of retort........	500°	700°	800°	900°
Yield of gas per gallon of oil..	12 c.p.	60 c.p.	72 c.p.	84 c.p.
Illuminating power..........	54·8	50·7	57·1	42
Unsaturated hydrocarbons....	39·13	36·56	36·55	22 04
Acetylene..................	0·052	0·084	0·38	0·46

ADDITIONS TO THE LIBRARY.

Pamphlets presented by the Authors.

On the Causes of the Phenomena of Terrestrial Magnetism, by H. Wilde, F.R.S. 4to. London 1891.

Sul calore specifico del diamante, per C. E. Carbonelli. Genova 1891.

Steel Rails considered Chemically and Mechanically, by C. P Sandberg 1890.

A Modification of the Reichert Distillation Process for Butter, by H. Leffmann and W. Beam. Philadelphia 1891.

Perchè sia a preferirsi il metoto di Persoz nell' analisi dei nitrati di potassio e di sodio commerciali, per C. de Negri. Genova 1891.

Estimation of Nitrogen in Nitrates by Kjeldahl's method, and an Index to the Literature on the Estimation of Nitrogen, by L. F. Kebler. Michigan 1891.

London Smoke Plague, by B. H. Thwaite. London 1891.

The Truth on Melinite, by E. Turpin. Braine-le-Comte 1890.

Report on the Analysis of Water from the Artesian Well in Stoney Lane, Houndsditch, by W. S. Saunders. London, 1891.

An Explanation of the Constitution of the Ether, of the Constitution of Matter, and of the Cause of Universal Gravitation, by J. G. Vine. London 1891.

Field Experiments: Barley, Field No. 11. Plots 1—24; Pasture, Field No. 13, by E. Kinch. Cirencester 1891.

The Sources of the Nitrogen of our Leguminous Plants, by J. B. Lawes and J. H. Gilbert. London 1892.

Observations on Rainfall, Percolation and Evaporation, by J. H. Gilbert. London 1891.

Sur la dypnone, par M. Delacre. Bruxelles 1890.

Notes on the Spectra of Zinc and Cadmium, by J. B. Kirkland. Melbourne 1890.

Wattles and Wattle Barks, by J. H. Maiden. 2nd Edition. Sydney 1891.

Contributions to the Study of the Pyroxenic Varieties of Gneiss and of the Scapolite-bearing Rocks of Ceylon and Salem, by M. A. Lacroix. Translated by F. R. Mallet.

ANNIVERSARY MEETING AND SECOND ANNIVERSARY DINNER.

A letter in the following terms has been issued by the Secretaries to all Fellows on the Home list:—

"We have the honour to inform you that the Society's Second Anniversary Dinner is to take place at the Hôtel Métropole on Wednesday, March 30th, at seven for half-past seven o'clock, the Anniversary Meeting being appointed to take place at Burlington House at 4 o'clock in the afternoon of the same day.

"The price of the dinner, including wine, will be One guinea, payable in advance.

"We beg to request that you will return the enclosed post card duly filled in not later than March the 19th.

"A ticket admitting to the dinner will be sent to you on receipt of £1 1*s*., the price of the dinner ticket."

At the next meeting, on March 17th, the following papers will be read :—

"The conditions which determine combination between the cyanides of zinc and mercury and the composition and properties of the resulting double salt." By Professor Dunstan.

"A lecture experiment to illustrate the phenomena of coal-dust explosions." By Professor Thorpe, F.R.S.

"The ketone obtained by the action of dehydrating agents on camphor." By Drs. Armstrong and Kipping.

"Platinum tetrachloride." By F. Pullinger, B.A.

HARRISON AND SONS, PRINTERS IN ORDINARY TO HER MAJESTY, ST. MARTIN'S LANE.

Issued 26/3/1892.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

No. 109. Session 1891–92.

March 17th, 1892. Dr. W. J. Russell, F.R.S., Vice-President, in the Chair.

Messrs. John C. Hewlett, William Pullinger, Edward C. Cyril Baly and John C. Chorley were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Hudson Donaldson, Trevyr House, Grantham; Henry Leonard Humell, 15, Mawdsley Street, Bolton; Cresacre George Moor, B.A., St. Clement's Vicarage, Truro; John Meadows Smith, 66, College Street, Chelsea, S.W.; George de Roos Thomson, 28, Treleth Road, Askam-in-Furness, Lancashire; Arthur Holt Tuer, Thornhill, Wigan, Lancashire.

Of the following papers those marked * were read:—

*121. "A study of the conditions which determine combination between the cyanides of zinc and mercury; and of the composition and properties of the resulting double salt." By Wyndham R. Dunstan.

When a solution of zinc sulphate is added to a solution of mercuric potassium cyanide [$HgK_2(CN)_4$], or when mercuric chloride is added to a solution of zinc potassium cyanide [$ZnK_2(CN)_4$], a white precipitate is formed which has been stated, on the authority of Gmelin, to consist of a double cyanide of zinc and mercury of the formula $ZnHg(CN)_4$. This, the author has shown, is not the case (*Pharm. J.*, **3**, 20, 653; *C.S. Abstr.*, 1890, 855). The precipitate loses a large quantity of mercuric cyanide when it is washed with cold water, some, however, remaining attached to the cyanide of zinc. Previous experiments seemed to point to the conclusion that the mercuric cyanide thus retained is not combined, but in some manner mechanically entangled by the zinc cyanide. This view is, however, disposed of by further experiments, of which an account is now given.

The precipitate is in many respects a remarkable substance. The amount of mercuric cyanide "retained" is dependent on the amount of water present during precipitation, as well as on the proportion in which the salts interact; the maximum quantity retained is 38·5 per cent. Zinc cyanide having this percentage of mercuric cyanide attached to it in such a form that it cannot be removed by ordinary washing with cold water is precipitated when cold saturated solutions of the two salts are mixed in equimolecular proportions. The washed precipitate is amorphous. Prolonged contact with cold water leads to the gradual removal of mercuric cyanide. Boiling water dissolves the mercuric salt more rapidly. A cold solution of potassium iodide readily dissolves the mercuric cyanide with the formation of the soluble double salt $Hg(CN)_2{\cdot}2KI$.

A series of experiments in which the masses of the interacting salts were varied proved that a compound of the two cyanides is formed, and suffers decomposition to a greater or less extent, depending on the relative amount of water present. An examination of the curves plotted from these results leads to the inference that the composition of the double salt is expressed by the formula $Zn_4Hg(CN)_{10}$, that is to say, the two cyanides are present in it in the proportion $Zn(CN)_2,\frac{1}{4}Hg(CN)_2$. Such a salt contains 40·6 per cent. of mercuric cyanide. It cannot be obtained pure, since it is decomposed by water, and it can only be produced by precipitation of aqueous solutions. Under the most favourable circumstances, when the quantity of water present is reduced to a minimum, a substance containing 98 per cent. of the double cyanide is obtained; the remaining 2 per cent. consists of zinc cyanide, resulting from the decomposition of some of the double salt by water, the mercuric cyanide being dissolved, whilst the insoluble zinc cyanide remains mixed with the double salt. All attempts to prepare the double cyanide by other methods than that of precipitation have failed. Fundamental molecules of zinc cyanide and mercuric cyanide must apparently be present, in order that combination may occur. The aggregates of fundamental molecules $[Zn(CN)_2]_n$ and $[Hg(CN)_2]_n$, which constitute the solid salts, show no tendency to combine. No evidence is forthcoming of the existence of any other compound of the two cyanides than that now described. No similar compound of zinc cyanide with other metallic cyanides than that of mercury could be obtained.

This tetrazincic monomercuridecacyanide, mixed with more or less zinc cyanide, has been found by Sir Joseph Lister to be an admirable surgical antiseptic, and it is at his suggestion that the enquiry was undertaken.

A full account of the best method of preparing the salt is given in the author's previous paper.

Discussion.

Sir Joseph Lister said that the great value of the salt arose from the circumstance that while equally effective as an antiseptic, it had none of the irritant qualities of mercuric cyanide; and its slight solubility was an advantage. When mercuric chloride was used, it was liable, on the one hand, to be washed away by the discharges, and, on the other, to accumulate until a solution was formed which was so concentrated that it caused great irritation.

*122. "A lecture experiment to illustrate the phenomena of coal-dust explosions." By T. E. Thorpe, F.R.S.

The author describes an apparatus by which the phenomena of a coal-dust explosion, resulting either from a local explosion of fire-damp or by the direct action of a blown-out shot, may be illustrated. For class-room demonstration he recommends the substitution of lycopodium powder for the coal-dust, on account of the greater ease and certainty of the experiment, and also because its use allows of the observance of certain phenomena, such as the mode in which the dust which escapes complete combustion is thrown on projecting objects, and also the fact that the explosion gathers strength as it progresses, which is made evident by the gradually increasing area of clear space before such objects as the dust is swept away by the force of the explosive flame.

By observations made by means of a List manometer with this apparatus, he finds that there is no evidence of a diminution of pressure along the sides of the space through which the flame rushes, and he is of opinion that there is no experimental proof of the validity of the "suction theory" held by certain colliery managers, which assumes that in consequence of this alleged diminution of pressure occluded fire-damp is drawn out from the coal, and contributes to the violence of the explosion.

Discussion.

Mr. Howard referred to two cases of "dust" explosions within his experience: one had occurred in a mill in which cinchona bark, a by no means inflammable substance, was ground; in the other case, soot produced by the burning of camphor had exploded after the fire itself had been put out.

Professor THORPE, in reply to a question of Mr. Bevan, said that although the explosion of coal-dust was doubtless influenced by its composition, the condition of the dust appeared to be the more important factor. Mr. Newth had found that charcoal powder would explode.

*123. "The production of the ketone 1 : 2 : 4-acetylorthoxylene from camphor by the action of sulphuric acid and zinc chloride." By Henry E. Armstrong and F. Stanley Kipping.

In a recent communication (these Proceedings, 1891, 188) the authors stated that they had separated from the crude product of the action of sulphuric acid on camphor a ketone of the formula $C_9H_{12}O$, mentioning that the results obtained on analysing its hydroxime were unsatisfactory; subsequent analyses of the hydroxime and several other derivatives of the ketone have, however, all given results confirming the formula $C_9H_{12}O$.

On treatment with bromine, the ketone yields an unstable bromide which readily decomposes, yielding the monobromo-derivative, $C_9H_{11}BrO$; this latter crystallises from petroleum spirit in colourless, lustrous flakes melting at 63—64°.

On oxidation with dilute nitric acid, the ketone yields two acids separable by means of chloroform. One of these proves to be paraxylic acid, *i.e.*, 1 : 2 : 4-dimethylbenzoic acid; the other being xylidinic, or 1 : 2 : 4-methylisophthalic acid. The formation of these two acids served to show that the ketone is 1 : 2 : 4-acetylorthoxylene, a compound which had already been prepared synthetically by Claus by the interaction of acetic chloride and orthoxylene in presence of aluminium chloride. The description of his product given by Claus was found to be substantially applicable to the product from camphor, but all doubt was set at rest by a direct comparison of the ketone prepared in accordance with Claus's directions with that obtained from camphor.

The theoretical bearing of this result will be fully discussed in the complete paper.

The authors are still engaged in examining the crude product containing the ketone, in order to ascertain the nature of the constituent which communicates to it the characteristic, strong, peppermint-like odour which it possesses, and which appears not to be exhibited by pure acetylorthoxylene.

*124. "Platinum tetrachloride." By W. Pullinger, B.A.

The author has obtained this substance by heating hydrated hydrogen platinic chloride in a current of dry hydrogen chloride at

165° during 15 hours. When thus prepared, it is a very soluble, but not deliquescent, substance.

125. "Note on a new acid from camphoric acid." By W. H. Perkin, jun., PhD., F.R.S.

When warmed with sulphuric acid at 65°, camphoric acid is converted into sulphocamphoric acid with loss of water and carbon monoxide: $C_{10}H_{16}O_4 + H_2SO_4 = C_9H_{16}SO_6 + CO + H_2O$. This remarkable decomposition was first examined by Walter (*Ann. Chim. Phys.* [3], **9**, 177); subsequently by Kachler (*Annalen*, **169**, 183), and by Zepharovich (*Jahresb.*, 1877, 641). Kachler showed that, when fused with potash, sulphocamphoric acid yields a crystalline substance, $C_9H_{12}O_2$ (m. p. 148°), which, although soluble in alkalis, is apparently not an acid.

In repeating Kachler's experiments, the author sulphonated camphoric acid at 100°, and fused the resulting sulphonic acid with potash, according to Kachler's directions. The resulting product was distilled under reduced pressure, and the distillate, which on cooling completely solidified, was purified by means of baryta-water, and subsequent recrystallisation from dilute acetic acid. It was thus obtained in the form of beautiful, glistening prisms which melt at 108° and sublime readily at 100°. The analysis gave the following numbers:—

	Theory, $C_9H_{12}O_2$.	Found.
C	71·0 per cent.	70·7 per cent.
H	7·9 ,,	8·1 ,,

This compound, which is isomeric with that described by Kachler, is a well characterised monobasic acid. The *silver salt*, $C_9H_{11}AgO_2$, was obtained on adding silver nitrate to a neutral solution of the ammonium salt as a white, crystalline precipitate, which, on analysis, gave the following numbers:—

	Theory, $C_9H_{11}AgO_2$.	Found.
C	41·7 per cent.	41·5 per cent.
H	4·3 ,,	4·4 ,,
Ag........	41·7 ,,	41·8 ,,

From these results it would appear that the acid obtained by sulphonating camphoric acid at 100° is isomeric with ordinary sulphocamphoric acid. The author is engaged in an experimental comparison of these sulpho-acids, and also with a detailed investigation o the new acid and of Kachler's isomeric compound.

126. "The specific rotatory and cupric reducing power of invert sugar and of dextrose obtained from cane sugar by means of invertase." By James O'Sullivan.

After referring to the various values assigned to the rotatory power of lævulose and to the doubt thrown on Dubrunfaut's value by the statements of Herzfeld, Bornstein and Winter, the author minutely describes experiments in which hydrolysis of cane sugar was effected by invertase instead of by means of acid. The conclusion finally arrived at is that, as the specific rotatory power of invert sugar obtained by means of invertase, which has no action on lævulose, is $[\alpha]_j = -24{\cdot}5^\circ$, and that of the dextrose prepared from such invert sugar is $[\alpha]_j = 57^\circ$, the apparent specific rotatory power of lævulose calculated from these numbers must be $-24{\cdot}5 \times 2 + 57^\circ = [\alpha]_j$ -106 or $[\alpha]_D -93\ 8$, a value agreeing with that generally accepted.

127. "Ethyldimethylamidobenzene." By W. R. Hodgkinson and Leonhard Limpach.

The authors have prepared this amine by heating paraxylidine chlorhydride with ethylic alcohol under pressure at 250—300°; the product also contains diethyldimethylamidobenzene. The purification was effected by converting the mixture into sulphates; after recrystallising the difficultly soluble sulphate of the ethyldimethylamine, the formyl compound was prepared and crystallised from weak alcohol.

The pure amine boils at 247°; its formyl derivative crystallises in long, silky needles melting at 104—105°; its acetyl derivative forms brilliant prisms melting at 142—143°.

128. "Action of nitric acid on oxanilide and its analogues." By A. G. Perkin.

Although acetanilide and similar compounds are readily converted into mononitro-derivatives, the preparation of dinitro-compounds from them is often attended with difficulty, and trinitraniline has not hitherto been obtained directly from aniline or its derivatives. The author finds that oxanilide and its analogues are readily converted by nitration into the higher nitro-derivatives.

An improved method of preparing oxanilide and similar compounds is described, consisting in adding the oxalate of the amine to boiling coal tar cresylic acid and boiling the saturated solution for a few minutes.

The preparation and properties of the following substances are described :—

Tetra- and hexa-nitroxanilide.
Di- and tetra-nitroxalorthotoluide.
Tetranitroxalparatoluide.
Dinitroxal-β-naphthylide.
$\left.\begin{array}{l}\text{Tetranitroxal-}\alpha\text{-}\\ \quad\quad\text{,,}\quad\quad\text{-}\end{array}\right\}$ naphthylcarbamide.
Mono-, di- and tri-nitroxanilic acids.

Higher derivatives of the toluides could not be obtained; the naphthylcarbamide derivatives were obtained as products of the continued action of nitric acid on the dinitroxalnaphthylides.

ADDITIONS TO THE LIBRARY.

Donations.

Grundlagen der Chemie, von D. Mendelejeff, übersetzt von L. Jawein und A. Thillot. St. Petersburg 1891.

From Prof. Mendelejeff.

Publications de l'Institut Royal Grand-ducal de Luxembourg (Section des Sciences Naturelles et Mathematiques). Tome XXI. Luxembourg 1891.

Observations Météorologiques faites à Luxembourg de 1884—1888. Moyennes de 1884—1888 et de 1854—1888, par F. Reuter-Chomé. Tome V. Luxembourg 1890.

From the Institut Royal de Luxembourg.

At the next meeting, on April 7th, the following papers will be read:—

"Platinous chloride and its use as a source of chlorine." By W. A. Shenstone and C. R. Beck.

"The action of silicon tetrachloride on substituted phenylamines." By Professor Emerson Reynolds, F.R.S.

ANNIVERSARY MEETING AND SECOND ANNIVERSARY DINNER.

The Anniversary Meeting will be held at *Four o'clock in the Afternoon* of Wednesday, March 30th next.

The Anniversary Dinner will take place at the Hôtel Métropole (Whitehall Rooms), at seven for seven-thirty o'clock in the evening.

HARRISON AND SONS, PRINTERS IN ORDINARY TO HER MAJESTY, ST. MARTIN'S LANE.

Issued 20/4/1892.

PROCEEDINGS
OF THE
CHEMICAL SOCIETY.

No. 110. Session 1891–92.

March 30th, 1892. Annual General Meeting. Professor Crum Brown, F.R.S., President, in the Chair.

The President delivered an address, of which the following is an abstract:—

The number of Fellows of the Society is 1855, including 30 foreign members, 120 Fellows having been admitted during the year.

The Society has to deplore the loss of two veteran foreign members, Hermann Kopp and Jean Servais Stas. The Treasurer has undertaken to give an account of the work of the former and to sketch the modern development of his ideas in a lecture to be delivered during the coming session. It is hoped that in like manner justice may be done to the work of Stas by one of the Fellows specially qualified to deal with such a subject.

The following tabular statement gives the numerical position of the Society:—

Number of Fellows (Anniversary, March, 1891)		1754
Since elected and paid admission fees................		120
		1874
Removed on account of arrears	18	
Withdrawn................................	18	
Deceased.................................	13	
		49
Present number of Fellows		1825
Number of Foreign Members (1891)..........	32	
Deceased.................................	2	
Present number of Foreign Members................		30

13 Fellows have died within the year:—Dr. J. H. Abrahall, Dr. A. J. Bernays, Chas. Heisch, H. J. Hardy, T. H. Hills, J. S. Jackson, J. B. Mackintosh, C. McNally, J. W. Pratt, Dr. Redwood, A. J. Shilton, Dr. Tidy and P. H. Wright.

18 Fellows have withdrawn:—H. H. Bunting, W. L. Clarke, W. Y. Dent, Rev. G. R. Faulkner, Robt. Ferguson, Thos. Hilditch, Rev. T. Lindsay, Wm. Robinson, J. B. Readman, W. H. Reid, Chas. T. Sprague, George Sutcliffe, C. H. Sieber, Saml. D. Wills, J. C. Watson, W. C. Wise, Prof. E. Marks and D. T. C. Charles.

18 Fellows have been removed on account of arrears:—T. S. Conisbee, W. Crossley, Albert Cobb, Ed. Dawson, Chas. Hulke, Wm. Houlding, H. E. J. Irons, A. J. G. Lowe, Rev. S. Langdon, Eberhard Luttgen, Jas. Mayne, E. W. Parnell, Wm. Rupp, S. A. P. Szczepanowski, Edward de Souza, Arthur Stanley, W. B. Turner and T. E. Towerson.

No fewer than 128 papers have been read, the largest number on record. The 1891 volume of the Transactions contains 95 original papers, occupying 1100 pages, while the Abstracts occupy 1564 pages.

At the commencement of the winter session Professor Attfield brought under the notice of the Council his proposal for establishing a Chemists' Benevolent Fund. A Committee was appointed to consider this proposal, and eventually they presented the following Report, stating that it represented their unanimous opinion:—

REPORT OF COMMITTEE ON A "CHEMISTS' BENEVOLENT FUND."

RESOLUTION of Council, passed November 19th, 1891:—

> "That a Committee be appointed to consider the letters from Professor Attfield, of October 2nd and November 16th, 1891, relating to a Chemists' Benevolent Fund, and to report as to the course of action they deem most prudent for the Council to take with regard to the matter.
>
> "That the Committee consist of—
>
> Sir F. A. Abel, F.R.S.
> Prof. A. Crum Brown, F.R.S.
> Dr. J. H. Gladstone, F.R.S.
> Dr. Hugo Müller, F.R.S.
> Prof. W. Odling, F.R.S.
> Dr. W. J. Russell, F.R.S.
> Prof. T. E. Thorpe, F.R.S.
> Prof. J. M. Thomson."

REPORT.

1. Your Committee beg to report that they have held four meetings on the subject, and have given careful consideration to the proposal

for the foundation and administration by, or in connection with, the Chemical Society of a "Chemists' Benevolent Fund," as set forth in Professor Attfield's letter of November 16th, addressed to members of the Council, and more fully in his circular of October 2nd, 1891. Your Committee, at one of their meetings, had the advantage of Professor Attfield's attendance, and have since been in further communication with him.

2. Your Committee, while sympathising with the general object sought to be attained, and making hearty acknowledgment of the zeal displayed by Professor Attfield in the steps taken by him to initiate the proposed Fund, feel that they have been placed in a position of some difficulty by reason of the indefinite character of the particular proposal presented for their consideration.

3. In his letter of November 16th, Professor Attfield refers members of the Council to his circular of October 2nd, as "containing the conditions under which the contributions were obtained;" but neither from this circular nor from Professor Attfield himself, by whom alone these conditions appear to have been propounded, have your Committee been able to ascertain which of the somewhat vaguely expressed conditions set forth in the circular are to be regarded as mere suggestions for the consideration of, and which as stipulations obligatory upon, the administrators of the proposed fund, in order to entitle them to the contributions so generously promised thereto.

4. So far as your Committee can gather, however, it was Professor Attfield's intention to invite contributions to a Fund to be founded in celebration of the Jubilee of the Chemical Society, and to be dealt with as follows:—1. "The *supervision*, at least, of both foundation and administration," to be undertaken by the Council of the Chemical Society. 2. The details of administration to be conducted by "a Board of Fellows (of the Society), so selected by the Council as to be representative of all classes of chemists." 3. The benefit not to be limited to investigators and exponents of chemical science, or to Fellows of the Society, but to be open to any one of whom it could be said, "that he is *boná fide* a chemist and is in distress." 4. The main purpose to be "the permanent relief of distressed chemists or their widows," and its aim to "be to provide annual pensions . . . . to approved applicants of a given age." 5. The selection from among these approved applicants to be "by votes (of subscribers), under which only the fittest for relief will be relieved," a mode represented to be the only practicable one for the distribution and sustentation of a competitive pension fund, framed as contemplated, on the lines of the Benevolent Fund of the Pharmaceutical Society.

5. Your Committee have grave doubts whether such a system of

competitive annuities, under which, on an annuity becoming publicly announced as vacant, the successful applicant would secure, it might be, an undue measure of relief, while other scarcely, if at all, less deserving applicants might receive no relief at all, is a judicious or even defensible system. They consider a far more desirable plan to be that of entrusting a select body of administrators to deal privately with every case as it is brought to their notice, either by pension or otherwise, according to the circumstances of the particular case; and as regards any surplus of yearly income, either to add it to the capital fund, or let it be available for the requirements of after years, so as to make provision against the occurrence of occasional cases of urgency.

6. But whatever may be thought of these alternative modes of administering a Benevolent Fund, and putting aside for the moment the question both of the advisability or otherwise of the institution *by the Chemical Society* of any Benevolent Fund at all, and of the legal difficulties which the institution of such a Fund would have to encounter, your Committee are unhesitatingly of opinion that the administration of any Fund instituted by the Chemical Society ought to be wholly unfettered by conditions imposed from without, and be conducted solely according to regulations approved and authorised by the Society itself from time to time.

7. Your Committee, while recognising that, under the Charter of the Chemical Society, the creation or acceptance of a Benevolent Fund by the Society would be attended with serious difficulty, have little doubt but that if the institution of the Fund were felt to be eminently desirable, this difficulty might, in some way or other, be obviated or overcome. But taking into account all the circumstances, and especially the considerations stated below, they question very much whether the resulting advantages would not be more than counterbalanced by the disadvantages attendant on the institution and administration of any such Fund by the Society.

8. As sustaining their doubts on this point, your Committee feel that, to whatever extent Professor Attfield's, or some other like, Fund is, or might be, intended to afford relief to persons whose claim would be based in any way on the contributions they had made to the advancement of chemical science, the necessities of such persons are met in very full measure by the Scientific Relief Fund of the Royal Society; and that, so far as this class of persons is concerned, the effect of the institution of a distinct Relief Fund by the Chemical Society would be, *pro tanto*, to liberate the existing Royal Society Fund from its present obligations towards necessitous scientific chemists and their families, and thereby to withhold from this class of persons in the future the ready and very liberal support from that Fund which has heretofore been accorded them.

9. On the other hand, as regards the large, and often poorly remunerated, class of persons whose claim to relief from the proposed new Fund would be based, not on their contributions to chemical science, but on the circumstance of their having been, in different grades, honourably and usefully engaged in the practice of professional chemistry, your Committee cannot but bear in mind that the Chemical Society, though founded mainly by professional chemists, was not founded for any professional object, but solely for the advancement of the science of chemistry; and that the Society, from its origin until the present day, while sympathising with the actively progressing development of professional chemistry, and with the measures taken of late for its better recognition, has consistently declined to regard the interest of professional chemists as one with which it was especially concerned, or for which it could accept any responsibility. This being so, it would, in the opinion of your Committee, be unwise for the Society to abandon, and to lay itself open to the imputation of having been ready at once to abandon, its settled and well recognised policy, as soon as it became a question of acquiring funds for the Council of the Society to control and, directly or indirectly, administer.

10. Having regard to the objects for which the Chemical Society was instituted and incorporated, it is clear that the management of its affairs must be *mainly* in the hands of the most active and distinguished of the workers in chemical science; and it appears to your Committee that the privately conducted administration by the Council of the Society, or any delegacy appointed by, and responsible to, the so constituted Council, of a Fund to be shared in common by one set of persons whose claim would be based on their contributions to chemical science, and by another and larger set of persons whose claim would be based on their engagement in chemical practice, could scarcely fail to provoke a well-founded dissatisfaction among the latter class; while a resort to any form of popular election or control would as certainly be prejudicial to persons of the former class, whose interests the Chemical Society is more especially under obligation to shield and have regard for.

11. On these grounds then, namely, the sufficiency on the one hand of the continuously increasing Scientific Relief Fund of the Royal Society to meet the distresses of persons engaged in the advancement of chemical science, and the unfitness, on the other hand, of the Chemical Society to undertake the responsibility of providing for the distresses of persons engaged in chemical practice, as well as on the legal difficulty to be got over, and on yet other grounds, which, though felt to be of importance, it has not been thought necessary to dwell on, your Committee have reluctantly come to the conclusion that they cannot recommend the Council to undertake the charge

with which it has been proposed to intrust them as representing the Chemical Society, of founding and administering a "Chemists' Benevolent Fund."

Signed on behalf of the Committee,

F. A. ABEL.

January 29, 1892.

This Report was considered and adopted by the Council, and by their unanimous vote it was resolved :—

"That the Report of the Committee on the proposed institution by the Chemical Society of a 'Chemists' Benevolent Fund' be received and entered upon the Minutes.

"That in view (*a*) of the claims of scientific chemists on the Relief Fund of the Royal Society; (*b*) of the difficulties that would attend the establishment and satisfactory administration of a separate Fund by the Chemical Society; and (*c*) of the conditions affecting the particular scheme, Professor Attfield's proposal for the establishment of a 'Chemists' Benevolent Fund,' in connexion with the Chemical Society, be not entertained.

"That a copy of this Resolution be forwarded to Professor Attfield, with an expression of thanks to him personally for the unsparing efforts he has made in the matter, and to the promised contributors to the suggested Fund for their generously proffered support thereto."

A Committee of the Council have had under consideration the question of the entire rearrangement, ventilation, and lighting of the meeting room, and with the cooperation of Professor Ayrton and Mr. Martin L. Saunders (architect) have prepared a scheme which is now under the consideration of Her Majesty's Office of Works; if approved, this will be carried into effect during the long vacation.

In the remainder of his address, the President dwelt chiefly on the work which is being done on the border lines of chemistry proper—referring both to that by which an approach is gradually being made towards understanding the chemistry of Nature's organic laboratory; and to the application of mathematical and physical methods of enquiry to the solution of chemical problems.

Sir Henry Roscoe proposed a vote of thanks to the President, coupled with the request that he allow his address to be printed. Dr. Gladstone seconded the motion, which was carried by acclamation. The President having thanked the meeting, Professor Thorpe, the reasurer, gave an account of the balance sheet which he laid before the Society duly audited. The receipts had been:—By admission fees and subscriptions, £3545; by sale of Journal, £408 7*s.* 4*d.*; and by dividends on invested capital, £367 12*s.* 10*d.* The expenses had been:—On account of the Journal, £2798 15*s.* 10*d.*; on account of the Proceedings, £159 14*s.* 5*d.*; on account of the Library, £277 6*s.* 2*d.*; the total expenditure being £3989 1*s.* 6*d.* Grants amounting to £406 5*s.* 4*d.* had been made to Fellows from the Research Fund during the year. As illustrating the growth of the Society's work, the Treasurer mentioned that whereas the expenditure on the Journal had been only £1733 11*s.* 10*d.* in 1882, in 1887 it had risen to £2026 16*s.* 9*d.*, and this year amounted to £2798 15*s.* 10*d.* He anticipated that the proposed alterations and redecorations of the Society's rooms during the coming long vacation would absorb nearly £1000 of the balance now at the bank.

Mr. David Howard proposed that the thanks of the Fellows be tendered to the Treasurer for his services during the past year; this motion was seconded by Professor E. Frankland.

Sir Henry Roscoe having asked for information with reference to the Report of the Jubilee Meeting, and with regard to the Learned Societies' Registration Bill, both items of charge in the balance sheet, Dr. Armstrong said that the former was in hand, and would ere long be ready for issue; unfortunately they had been unable to induce any Government Department to take charge of the Registration Bill, and he feared that there was but little chance of getting it brought forward unless promoted as a private measure.

Mr. Cassall, after a reference to the cost of printing the suggested alterations in the bye-laws, which he supposed was included in the cost of printing the Proceedings, asked the President whether he had received a letter, and was prepared to consider the request therein made that he would inspect the documents in which a number of Fellows of the Society had expressed their wishes with reference to the suggested alterations in the bye-laws.

The President replied that he had received a letter signed by Dr. Teed and Mr. Cassall, and that he could only say that a letter from even one Fellow of the Society would meet with every consideration from him.

The vote of thanks to the Treasurer having been passed, the Treasurer proposed a vote of thanks to the Auditors, mentioning that he was much indebted to Mr. Tutton for his assistance in connection with the accounts. Professor Ramsay seconded the motion, which was unanimously adopted, and acknowledged by Mr. Dyer.

Professor Odling then proposed a vote of thanks to the Council and Officers, including the Editors, Abstractors, and Librarian. Mr.

Carteighe supported the motion, which was adopted. Dr. Armstrong and Mr. Groves having replied,

Scrutators were appointed, and a ballot was then taken for the election of Officers and Council for the ensuing year: the following were subsequently declared elected.

President: Dr. A. Crum Brown, F.R.S.

Vice-Presidents who have filled the office of President: Sir F. A. Abel, K.C.B., D.C.L., F.R.S.; W. Crookes, F.R.S.; E. Frankland, D.C.L., F.R.S.; J. H. Gilbert, Ph.D., F.R.S.; J. H. Gladstone, Ph.D., F.R.S.; A. W. Hofmann, D.C.L., F.R.S.; H. Müller, Ph.D., F.R.S.; W. Odling, M.B., F.R.S.; W. H. Perkin, Ph.D., F.R.S.; Sir Lyon Playfair, Ph.D., K.C.B., F.R.S.; Sir H. E. Roscoe, LL.D., F.R.S.; W. J. Russell, Ph.D., F.R.S.; A. W. Williamson, LL.D., F.R.S.

Vice-Presidents: A. Vernon Harcourt, F.R.S.; W. N. Hartley, F.R.S.; John Pattinson; William Ramsay, F.R.S William A. Tilden, F.R.S.; Robert Warington, F.R.S.

Secretaries: H. E. Armstrong, Ph.D., F.R.S.; J. Millar Thomson, F.R.S.E.

Foreign Secretary: Raphael Meldola, F.R.S.

Treasurer: T. E. Thorpe, B.Sc., F.R.S.

Ordinary Members of Council: Henry Bassett; Norman Collie, Ph.D.; Harold Dixon, F.R.S.; John Ferguson, M.A.; R. J. Friswell; John Heron; M. M. P. Muir; F. J. M. Page; W. H. Perkin, jun., F.R.S.; S. U. Pickering, M.A.; John A. Voelcker, Ph.D.; W. P. Wynne, B.Sc.

Second Anniversary Dinner. Wednesday, March 30th, 1892. Professor Crum Brown, F.R.S., President, in the chair.

Whitehall Rooms, Hôtel Métropole, 7.30 P.M.

The following Fellows and guests were present:—

Armstrong, Dr.
Atkinson, Dr.

Bassett, Mr. H.
Baumer, Mr.
Beckett, Mr. J.
Bevan, Mr. E. J.
Blount, Mr. Bertram.
Bottle, Mr. A.

Clarke, Mr. E.
Cooper, Mr. A.
Crookes, Mr. W.

Dodd, Mr.
Down, Mr.
Dunstan, Prof. Wyndham.
Dyer, Mr. Bernhard.
Dyer, Mr. Thiselton.

Fletcher, Mr. A. E.
Forbes, Mr. James.
Formoy, Mr.
Foster, Prof. Carey.
Foster, Mr. Wm.
Friswell, Mr.
Fuller, Mr. J.

Gilbert, Dr.
Gladstone, Dr.
Godson, Dr. R.
Gordon, Mr. J. G.
Greenaway, Mr. A. J.
Groves, Mr. C. E.

Hall, Mr. Samuel.
Harland, Mr. R. H.
Harley, Dr. George.
Harrison, Mr. J. W.
Harvey, Dr. Selwyn.
Harvey, Mr.
Hills, Mr. W.
Howard, Mr.
Howie, Mr.

Institute of Chemistry, President of the (Prof. Tilden).
Institute of Electrical Engineers, President of the (Prof. Ayrton).

Jamieson, Mr. A.
Jones, Rev. F.

Kellner, Dr.
Kemp, Mr.
Kinch, Prof.
Kingzett, Mr.

Lawson, Dr.
Lennard, Mr.
Louis, Mr. D. A.
Lister, Sir Joseph.

MacEwan, Mr.
Makins, Mr.
Marsh, Sir Wm.
Mond, Mr. R. L.
Moul, Mr.
Müller, Dr.
Meldola, Prof.
Morley, Dr. H. F.

Odling, Prof.
Odling, Mr.

Page, Mr. F. J. M.
Pattinson, Mr. J.
Pauson, Mr. M.
Perkin, Dr. W.
Perry, Prof.
Pharmaceutical Society, President of the (Mr. Carteighe).
Physical Society, President of the (represented by Prof. Reinold).
Ping, Mr. W.
Pullar, Mr. R.

Robertson, Mr.
Royal Institution, Treasurer of (Sir J. Crichton Browne).

Sibson, Mr. A. E.
Society of Public Analysts, President of the (Dr. Hehner).
Spiller, Mr. W.
Stevenson, Dr.
Symons, Mr.

The Times.
Thomson, Prof.
Thorne, Dr.
Thorpe, Prof.
Tookey, Mr. C.
Trewby, Mr. H.
Tyrer, Mr.

Voelcker, Dr. J.
Voelcker, Mr. E. W.

Ward, Prof. Marshall.
Watt, Dr. George.
Wynne, Mr.

The following toasts were proposed:—

By the President.

1. Her Most Gracious Majesty the Queen.
2. Their Royal Highnesses the Prince and Princess of Wales and the rest of the Royal Family.

By Professor Odling.

3. Kindred Societies and Institutions, coupled with the name of the President of the Institute of Electrical Engineers, Professor Ayrton.

By Sir Joseph Lister, Bart.

4. Chemical Science, coupled with the name of the President.

By Professor Thorpe.

5. The Visitors, coupled with the name of the Treasurer of the Royal Institution, Sir J. Crichton Browne.

Correction of a "Note on a new acid from camphoric acid." By W. H. Perkin, jun., F.R.S. (*ante*, p. 55).

The author desires to express regret that he had overlooked a previous paper by Damsky (*Ber.*, 1887, 2964), in which an account is already given of the acid recently described by him as new.

SESSION 1892–93.

April 7th, 1892. Dr. W. H. Perkin, F.R.S., Vice-President in the Chair.

Certificates were read for the first time in favour of Messrs. Fredk. William George Blyth, Clifton Wood, Clifton, Bristol; George Fitz-Brown, Ditton, Widnes; Walter William Duffield, 24, Ursula Street, Battersea, S.W.; Walter N. Edwards, 4, Herne Hill Road, Camberwell, S.E.; Harold F. Hills, 149, Bow Road, London, E.; John H. B. Jenkins, 23, Harding Street, New Swindon; Albert Morris, 115, Hope Street, Dukinfield; Joseph Charles Mulrenan, 45, Manor Road, Stoke Newington, N.; William Herbert Stables, B.A., Glebe House, Kirkstall, Leeds; Laurence John de Whalley, B.Sc., 26, Park Place, Greenwich.

Of the following papers, those marked * were read:—

*1. "The separation of arsenic, antimony, and tin." By John Clark, Ph.D.

The mixed sulphides of arsenic, antimony, and tin obtained in the ordinary course of analysis are dissolved in a strong solution of ferric chloride in chlorhydric acid, and the arsenic is distilled off and weighed as trisulphide. The residual liquid contains the antimony as trichloride, and the tin as stannic chloride, also ferrous and ferric chlorides. The author corroborates Loveton's statement that antimony and tin can be separated by taking advantage of the difference in solubility of their sulphides in solutions of hydrogen chloride of certain strengths, but thinks the proportion of acid should be reduced from a half to a third, to ensure the complete precipitation of the antimony, and to avoid the necessity of filtering through cotton wool. He recommends a combination of Loveton's and F. W. Clarke's processes, and without removing the iron salts he precipitates the antimony with hydrogen sulphide in a tepid solution containing from $\frac{1}{3}$ to $\frac{1}{4}$ of its volume of chlorhydric acid and a considerable quantity of oxalic acid. The precipitate, which is free from tin, is washed first with water, then with alcohol, and finally with carbon bisulphide, and weighed as Sb_2S_3 after being heated at a temperature of about 130° to ensure the complete expulsion of water. He considers this temperature sufficiently high to dry the Sb_2S_3. He points out that when Sb_2S_3 is dried at 130°, it suffers little or no further loss in weight till it is raised to the temperature at which it is converted into the black sulphide, and his experiments indicate that the loss in weight observed at this stage is not due to water but to oxidation, as after heating between 200° and 230° for several days there was a continuous loss, the black sulphide becoming brown, and it was found by analysis to consist chiefly of oxide of antimony.

When the Sb_2S_3 precipitate is large, it is necessary, after drying, to digest it in carbon bisulphide to extract the whole of the sulphur. To obviate this objection, the author reduces the excess of ferric chloride with thin sheet iron, and as soon as the yellow colour has disappeared, the undissolved iron is removed, and the antimony which has come down is redissolved with the aid of a little ferric chloride, which is added drop by drop till the solution is distinctly yellow to ensure that all the tin is in the stannic state ; a warm solution of oxalic acid containing about one-third of its volume of chlorhydric acid is then added, and the antimony is precipitated as Sb_2S_3, together with traces of sulphur, and washed with water, alcohol and carbon bisulphide.

After the removal of the antimony, the hydrogen sulphide is expelled by boiling, the oxalic acid decomposed with potassium permanganate, and the tin precipitated in a hot solution with hydrogen sulphide, and allowed to stand till cold. The SnS_2 obtained in this way can be filtered off and washed with water without passing through the filter. It is then converted, by ignition, into SnO_2, in which form the tin is weighed. The test analyses are very satisfactory.

For qualitative purposes, in distilling off the arsenic, a condenser is not necessary, a bent tube dipping into water being sufficient. It is advisable, however, to use a safety-tube to prevent the distillate coming back.

In the case of alloys, the metal is dissolved in strong chlorhydric acid with the aid of ferric chloride and the arsenic distilled off at once. The antimony and tin, after being separated from the other metals of the group, are then estimated in the manner described above.

*2. "Platinous chloride and its use as a source of chlorine." By W. A. Shenstone and C. R. Beck.

The authors have examined chlorine from six specimens of platinous chloride of independent origin, and have found oxygen and hydrogen chloride to be present in them all. From these results they conclude that platinous chloride made by any of the processes hitherto recommended, including that lately suggested by L. Pigeon, contains a very perceptible quantity of some basic compound, which gives off water together with the gases previously mentioned.

They have noticed that after mercury has been exposed to the action of chlorine in the presence of a trace of water, it becomes capable of absorbing hydrogen chloride; it is not yet certain whether this action depends on the presence of oxygen or not.

*3. "Note on the adhesion of mercury to glass in the presence of halogens." By W. A. Shenstone.

The author finds that carefully purified chlorine, bromine and iodine affect mercury like ozone, causing it to adhere to glass in a remarkably perfect manner.

*4. "The decomposition of mannitol and dextrose by the *Bacillus ethaceticus*." By Percy F. Frankland, F.R.S., and John S. Lumsden.

The products of the fermentation of both these compounds consist of ethyl alcohol, acetic acid, carbonic anhydride, hydrogen and traces of succinic acid. When the fermentations are conducted in a closed space, there is invariably also a considerable quantity of formic acid produced, whilst in fermentations in an open space (flasks plugged with cotton wool), formic acid, except in traces, is a most exceptional product. The same phenomenon has been already pointed out by one of the authors in the case of a fermentation with another organism (*B. ethacetosuccinicus*), and it is, doubtless, due to formic acid being one of the primary products of the fermentation, and then breaking up, more or less completely, into equal volumes of carbonic anhydride and hydrogen; this decomposition is, however, retarded when the products—carbonic anhydride and hydrogen—are prevented from escaping, as is the case in fermentations conducted in a closed space. Indeed, the proportion in which the carbonic anhydride and hydrogen were found coincides almost exactly with that in which they are present in formic acid. The proportions in which the several products are obtained from mannitol is approximately represented by the equation:—

$$3C_6H_{14}O_6 + H_2O = C_2H_4O_2 + 5C_2H_6O + 5CH_2O_2 + CO_2,$$

whilst in the case of the dextrose, the products occur in the proportions:—

$$2{\cdot}5C_2H_6O : 1{\cdot}5C_2H_4O_2 : 3CH_2O_2 : CO_2.$$

Thus, there is more acetic acid in proportion to alcohol and formic acid produced in the case of dextrose than in that of mannitol. The carbon dioxide given among the products really represents that liberated from the calcium carbonate present in excess by a fixed acid insoluble in ether, the nature of which could not be determined.

The fermentations conducted in a closed space are always found to be markedly less complete than those which take place in an open one.

There is a close qualitative and quantitative resemblance between these fermentations by the *B. ethaceticus* and those previously described by one of the authors as taking place through the agency of the *Pneumococcus* (Friedländer), which renders it probable that this ethacetic decomposition is a very general and typical form of fermentative change.

Discussion.

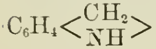
Dr. Armstrong, after remarking on the interest attaching to the discovery of formic acid, in considerable quantity, among products of fermentation, said that he could not think the explanation satisfactory which the authors had advanced of the non-production of this acid when closed flasks were used, viz., that the breaking up of the acid into hydrogen and carbon dioxide, which took place when fermentation was conducted in open vessels, was retarded by their presence when the products were prevented from escaping: that such an influence could be exerted on a fermentation from without was scarcely probable, according to present knowledge. It was more likely that there were distinct initial differences between fermentations carried on under the two sets of conditions.

Professor Frankland, in reply, said, that he thought the difference might be attributable to a difference in pressure, involved in collecting the gases, in the one case, over mercury, rather than to absence of air, and he was, therefore, at present studying the influence of pressure.

In reply to a question by Dr. Kipping, he added that it was very remarkable that, notwithstanding both alcohol and acetic acid were formed, no trace of ethylic acetate could be detected among the products.

*5. "The preparation of glycollic acid." By H. G. Colman.

Glycollic acid may be readily prepared by boiling a concentrated solution of potassium chloracetate for 24—30 hours in a flask connected with a reflux apparatus; the product, which consists of a solution of glycollic acid and potassium chloride, is distilled under reduced pressure, the temperature in the distilling flask not being allowed to rise above 70°, and the residue is mixed with a large quantity of acetone, filtered from the separated potassium chloride, and the acetone solution concentrated: glycollic acid soon separates out in colourless crystals, which only contain 0·5 per cent. of ash, and are sufficiently pure for most purposes. The yield is about 85 per cent. of the theoretical.

Glycollic anilide, $C_6H_5\cdot NH\cdot CO\cdot CH_2OH$, may be prepared by heating glycollic acid for some time at 240°, boiling the residue with aniline, and recrystallising the product from water; it has the properties assigned to it by Norton and Tscherniak (*Bull. Soc. Chim.*, **30**, 104). Attempts were made to convert this compound into oxindole,  $C_6H_4<\begin{matrix}CH_2\\NH\end{matrix}>CO$, by eliminating the elements of water, but without success; phosphorus pentoxide acts on the anilide, but the crystalline product consists simply of the phosphate $PO(O\cdot CH_2\cdot CO\cdot NH\cdot Ph)_3$.

According to measurements made by Mr. W. J. Pope, the crystals of glycollic acid obtained from an acetone solution belong to the orthorhombic system, $a : b : c = 0·774 : 1 : 0·368$, and exhibit the macropinacoid (100), the brachypinacoid (010), the macrodome (101) and the prism (110). Glycollic acid would seem to be dimorphous, as Groth has described (*Krys. Zeit.*, **5**, 309) crystals of the acid obtained from aqueous solution, which belong to the monosymmetric system. Glycollic anilide crystallises in the monosymmetric system, $a : b : c = 0·9322 : 1 : ?$; $\beta = 64° 55'$, and show the orthopinacoid (100), the basal pinacoid (001), and the prism (110).

6. "Researches on silicon compounds and their derivatives. Part VI. The action of silicon tetrachloride on substituted phenylamines." By J. Emerson Reynolds, D.Sc., F.R.S.

In Part V of this investigation the author described some members of a class of silicon compounds of the type $Si(RNH)_4$, obtained by the interaction of silicon tetrabromide and tetrachloride and aniline, ortho- and para-toluidine and α- and β-naphthylamine; the action of a silicon haloid on the secondary and tertiary alkaloids diphenylamine, ethylaniline and diethylaniline is now described.

Diphenylamine, when free from extraneous matter capable of decomposing silicon chloride, combines with the latter to form an unstable addition compound, which is decomposed below the boiling point of benzene. No interaction with the silicon haloid was obtained analogous to that which readily occurs with phenylamine.

Ethylaniline, on the contrary, is easily acted on by silicon chloride, ethylaniline chlorhydride separating, a liquid product being obtained containing the new compound $Si(PhNEt)_4$.

Diethylaniline, when pure, is but feebly acted on by silicon tetrachloride even when heated with it at 190° under pressure; no ethyl chloride separates, but the compound $PhNEt_2HCl$ is formed together with a liquid which probably contains the compound $Si(C_6H_5NEt_2)_4$.

It appears, therefore, that the substitution of phenyl for but one atom of hydrogen in aniline confers on the resulting alkaloid greater immunity from attack by silicon tetrachloride than displacement by ethyl of part or all the amidic hydrogen of aniline.

7. "Chemistry of the compounds of thiourea and thiocarbimides with aldehyde-ammonia." By Augustus E. Dixon, M.D.

In a previous paper (*Chem. Soc. Trans.*, 1888, 411) the author showed that the alkyl and allied thiocarbimides and aldehyde-ammonias interact in accordance with the equation:—

$$R{\cdot}NCS + 2R'CH(OH)NH_2 = CSN_3H_2R(CHR')_2 + 2H_2O,$$

and the possibility was suggested of a connection between the class of substances so formed and a compound obtained by Nencki (*Ber.*, **7**, 162) by the action of thiourea on aldehyde-ammonia.

The principal general results established by a continuation of this investigation are that Nencki's compound, a homologue of the latter (obtained from thiourea and valeraldehyde-ammonia), and the thiocarbimide derivatives formed in accordance with the equation above given agree in properties in the following respects:—

(1.) They combine with picric acid in equimolecular proportions.

(2.) They are decomposed by hot acetic anhydride, with separation of both aldehyde groups, together with one of the three nitrogen atoms, the corresponding acetylated thiourea being formed; while (3.) boiling with water effects an analogous decomposition, save that the resultant thiourea is non-acetylated.

(4.) They combine with silver nitrate, forming sparingly soluble addition products, which are more or less unstable in presence of water.

From this similarity in behaviour the inference is drawn that they are members of the same class.

Though thiourea and aldehyde-ammonia readily interact, this was not found to be the case when substituted thioureas were employed: under no circumstances (and the experiments were conducted under a great variety of conditions) was any sign of combination observed. This inertness is difficult of explanation if the monosubstituted thioureas possess the structure $\mathrm{CS}<^{\mathrm{NHR}}_{\mathrm{NH_2}}$, but is intelligible on the supposition that they are of the form $\mathrm{HN{:}C}<^{\mathrm{NH_2}}_{\mathrm{SH}}$. Evidence in favour of the latter formula has already been adduced from a slightly different point of view by Professor Emerson Reynolds (*Chem. Soc. Trans.*, 1891, 394), who, further, considers it probable that the substituting radicle displaces hydrogen in the imidic group.

The following compounds, amongst others, are described:—

Thiourea and valeraldehyde-ammonia, $CSN_3H_3(C_5H_{10})_2$—flattened, rhombic crystals, insoluble in water, and melting between 120° and 121° (uncorr.).

Methylthiocarbimide and acetaldehyde ammonia, $CSN_3H_2Me(CHCH_3)_2$—white needles, soluble in water and alcohol; melting point 142—143° (uncorr.).

Acetylthiocarbimide and aldehyde-ammonia, $CSN_3H_2Ac(CHCH_3)_2H_2O$—slender needles, soluble in water and alcohol; melting point 187° (uncorr.).

Phenylcarbimide and aldehyde-ammonia, $CON_3H_2Ph(CHCH_3)_2$—satiny needles, insoluble in water, sparingly soluble in alcohol; melting point 199—200° (uncorr.).

8. "The atomic weight of boron." By J. L. Hoskyns-Abrahall, B.A., Ph.D., late Bishop Berkeley Fellow of the Owens College. (Edited by T. Ewan and P. J. Hartog, of the Owens College.)

The deceased author determined the atomic weight of boron by estimating the amount of silver necessary to precipitate the bromine of a known weight of boron bromide. The editors have drawn up from the notes of the almost completed research a memoir which will shortly be submitted for publication. The results of the final series of determinations are as follows :—

Number of bulb.	Weight of BBr_3.	Weight of Ag.	Ratio of BBr_3 to Ag.	Atomic weight of boron (O = 16).
19	1·65511	2·13759	0·774288	10·838
23	4·46783	5·77127	0·774153	10·794
25	8·42315	10·88065	0·774146	10·792
11	7·72194	9·97405	0·774203	10·811
32	4·09274	5·28595	0·774268	10·831
10	8·03235	10·37420	0·774262	10·829

Mean error = 0·017.

The mean atomic weight is 10·816; the probable error being 0·0055.

The atomic weight obtained by taking the total of the mean weights of boron bromide and of silver used in the series of determinations is 10·811.

The atomic weights used in the calculation are Ag = 107·923, Br = 79·951. (Clarke, *Constants of Nature.*)

It is to be noticed that an experimental error of 1 part in 1000 in the determination of the ratio of boron bromide to silver will produce an error of 23 parts in 1000 in the atomic weight, owing to the small percentage of boron present in boron bromide.

ADDITIONS TO THE LIBRARY.

I. *Donations.*

Outlines of Theoretical Chemistry, by Lothar Meyer. Translated by P. P. Bedson and W. C. Williams. London 1892.
From the Translator.

Chemical Calculations, by R. L. Whiteley. London 1892.
From the Publishers.

Handbuch der Organischen Chemie, von F. Beilstein. Dritte Auflage. Lief 1. Hamburg und Leipzig 1892. From the Author.

Soils and Manures, by J. M. H. Munro and J. Wrightson. London 1892. From Dr. Munro.

Smithsonian Institution :—

Bureau of Ethnology. Omaha and Tonka Letters, by J. O. Dorsey. Washington 1891.

Catalogue of Prehistoric Works East of the Rocky Mountains, by C. Thomas. Washington 1891.
From the Institution.

Journal of the Royal Agricultural Society of England. Third Series. Vol. III. Part 1. London 1892. From the Society.

II. *By Purchase.*

Zeitschrift der anorganischen Chemie. Herausgegeben von G. Krüss. Band I. Heft 1. Hamburg und Leipzig 1892.

CERTIFICATES OF CANDIDATES FOR ELECTION AT THE NEXT BALLOT.

N.B.—The names of those who sign from "General Knowledge," are printed in *italics.*

The following Candidates will be balloted for on May 5th, 1892 :—

Barratt, Alexander,

Bronheulog, Mostyn, N. Wales.

Analytical Chemist. Three years Assistant Chemist at Works manufacturing Ferro-manganese, Spiegeleisen, Ferro-chrome, &c. Large experience in the Manufacture and Analysis of these Alloys and materials connected therewith. Hold First Class Certificates in Theoretical and Practical Chemistry.

W. F. Lowe. T. Vaughan Hughes. S. Sutcliffe.
John Pattinson. A. J. Greenaway.

Brown, Reginald Busby,

Ellerslie, Knighton Park Road, Leicester.

Dyer's Chemist. Formerly Student of Dyeing and Chemistry at Yorkshire College, under Professors Hummel and Smithells. For five years Chemist to Dyeworks; engaged in Testing New Colouring Matters; Investigating Properties of Dyestuffs, &c. Recently appointed Teacher of Harmony of Colour, Dyeing, and Practical Chemistry, as applied to the local industry, at Luton.

Arthur Smithells. J. J. Hummel. Walter M. Gardner.
A. Battye Knaggs. Herbert Ingle. *Henry R. Procter.*

Brown, George Fitz,

Ditton, Widnes.

Metallurgist. Manager, Copper Smelting Works. Associate Royal School of Mines. Fellow Institute of Chemistry.

J. Carter Bell. David Watson. W. Gowland.
Thomas Purdie. *W. F. Lowe.*

Blyth, Fredk. William George,

Clifton Wood, Clifton, Bristol.

Analytical Chemist. Chemist to the Bristol Gas Company. First Class Honours in Organic and Inorganic Chemistry.

Ernest H. Cook. Henry J. Palmer. Thos. Coomber.
J. Wertheimer. *James Leicester.*

Blyth, Meredith Wynter,

17, Marlborough Hill, N.W.

Assistant to Mr. J. K. Colwell, F.C.S., F.I.C., 30, Walbrook, London, E.C. (Public Analyst for Clerkenwell and Bedford), Undergraduate, University of London. Gas Examiner to the London County Council. Late Chemical Assistant to A. Wynter Blyth (Public Analyst for Marylebone and county of Devon), the Court House, S. Marylebone (two years). Previously Student of Chemistry for four years (one year King's College Laboratory, under Professor Millar Thomson, and three years at Court House Laboratory, Marylebone).

Jas. Kear Colwell. A. Wynter Blyth.
Charles E. Cassal. B. Henry Gerrans.
John M. Thomson. G. Stillingfleet Johnson.

Carey, Arthur,

Gateacre, near Liverpool.

Chemist. Bachelor of Science, Victoria, Honours Chem. Chemist to United Alkali Co. as Assistant to Dr. Hunter.

John Brock. J. Campbell Brown. Charles A. Kohn.
Alfred E. Fletcher. Edmund K. Muspratt.

Comyns, Frank, B.A.,

55, South Street, Durham.

Science Master, Durham School. Studied for three years in the Chemical Laboratories, and obtained Honours in the Natural Science School of the University of Oxford.

William Odling. W. W. Fisher. V. H. Veley.
John Watts. J. E. Marsh. D. H. Nagel.

Davies, Joseph,

28, Robarts Road, Anfield, near Liverpool.

Assistant Analytical Chemist. Formerly Student, and for several years Assistant, to A. Norman Tate, F.I.C., &c., Analytical and Consulting Chemist, Liverpool. Lecturer on Chemistry (Organic and Inorganic) to Liverpool Science and Art Classes, and the Balfour Institute, Liverpool.

A. Norman Tate. John H. J. Dagger. J. A. Foster.
Saml. Banner. *Edward Davies.* *Alexander Watt.*
W. Popplewell Bloxam.

Dodds, George Price,

3, Eversley Place, Heaton, Newcastle-on-Tyne.

Teacher of Chemistry, Allan's Endowed Schools, Newcastle-on-Tyne. First Class Certificates, Adv. Science and Art Department. Second Class Certificated Teacher of Chemistry, Royal College of Science, S. Kensington. Former Student at Bradford Technical College; present Student, Durham University College of Science, Newcastle-on-Tyne; two years Teacher of Chemistry, Allan's Endowed Schools.

Chas. Wood. S. Wood. James Spencer.
G. W. Slatter. *C. Rawson.*

Donaldson, Hudson,

Trevyr House, Grantham.

Director of Technical Instruction; Lecturer in Chemistry, Agriculture, and Agricultural Chemistry. Director of Technical Instruction; Lecturer under the Technical Instruction Committee, Lincolnshire (Kesteven) County Council.

G. H. Bailey. C. H. Corbett. Alfred Smetham.
G. W. Slatter. *James Spencer.*

Duffield, Walter William,

24, Ursula Street, Battersea, S.W.

Analytical Chemist and Gas Examiner. Since 1875 Assistant to the late Charles Heisch, F.C.S., F.I.C., &c.; the last 12 years as Chief Assistant. Since 1875 one of the Gas Examiners to the Corporation of the City of London.

A. Vernon Harcourt. W. C. Young. Bernard Dyer.
Otto Hehner. Greville Williams. Vivian B. Lewes.

Edwards, Walter N.,

4, Herne Hill Road, Camberwell, S.E.

Science Lecturer and Analytical Chemist. First Class Honours Practical Chemistry, Department of Science and Art. S. Kensington; First Class Certificate Inorganic and Organic Chemistry, ditto, ditto. Five years Studentship in Chemistry, Charterhouse Science School; two years Lecturer and Demonstrator Practical Chemistry, ditto, ditto. Member of Society of Chemical Industry (three years). Five years Lecturer on Popular Science Subjects.

John J. Pilley. James Edmunds. J. Hughes.
John Burgess. Walter A. Voss. *J. H. Gladstone.*

Ellison, Henry,

Whitechapel Road, Cleckheaton.

Manufacturing Chemist. Was at Bradford Technical College

(Chemistry and Dyeing Department) for four years, afterwards at Yorkshire College (Chemistry Department) for a session. Manager of Chemical Works.

C. Rawson.
Herbert Ingle.
James Spencer.
Arthur Smithells.
Charles H. Bothamley.
James R. Appleyard.

Fraser, James, F.R.S.S.A.,

Victoria Square, Adelaide, S. Australia.

Assayer and Analytical Chemist; Public Analyst. Practising in Adelaide between four and five years, after qualifying in Victoria at Melbourne University and Melbourne Government Laboratory.

Edward H. Rennie. T. J. Greenway. Gregory Board.
T. C. Cloud. L. R. Scammell.

Gargari, Haridas, M.A.,

Agra College, Agra, India.

Lecturer on Chemistry and Physics. Lecturer on Chemistry and Physics in the Free Church College, Calcutta, from 1879 to 1886, and in the Agra College from 1886 to present date.

Kanny Loll Dey. Alexr. Pedler. Ramchandra Dutta.
Tarapusauna Roy. Preo Lall Dey.

Hills, Harold F.,

149, Bow Road, London, E.

Assistant Analytical Chemist. For over four years Assistant to Mr. H. Leicester Greville, F.I.C., F.C.S., Analytical Chemist to the Commercial Gas Co. At present, and for past 13 months, Assistant to Mr. R. H. Harland, F.I.C., F.C.S., Analytical Chemist and Public Analyst.

R. H. Harland.
E. W. Whieldon.
A. P. Laurie.
H. Leicester Greville.
W. A. S. Calder.
W. C. Young.

Hinnell, Henry Leonard, A.M.I.C.E.,

15, Mawdsley Street, Bolton.

Civil and Sanitary Engineer. Have studied the Chemistry and Analysis of Water, Sewage, and Sludge, also various building materials. Engaged upon various sewage schemes for Corporations and other authorities, having designed works, and advised as to the different chemical effects obtained by the various processes for the purification of sewage. Author of work on "Treatment of Sewage."

Edward Sergeant.
J. Campbell Brown.
B. H. Thwaite.
Harold B. Dixon.
F. E. Adams.
W. B. Mason.

Hewitt, John Theodore,

St. John's College, Cambridge.

Assistant Demonstrator, University Laboratory, Cambridge. Papers on "Chlorinated Phenylhydrazines" and "Citraconfluoresceïn," Trans., 1890. Work on Anthrachinon Derivatives, jointly with Professor Gatterman. Worked as Student in the following:—Royal College of Science (Assoc. R.C.S.), Cambridge Univ. Lab. (B.A.), Heidelberg University Laboratory. B.Sc. London; Exhibitioner and Scholar in Chemistry; Hutchinson Research Student, St. John's College, Cambridge.

M. M. Pattison Muir. S. Ruhemann. A. Hutchinson.
Sidney Skinner. T. H. Easterfield.

Jenkins, John H. B.,

23, Harding Street, New Swindon.

Chief Assistant Analyst at Laboratory of Great Western Railway Company. Five years' experience in general Analytical Chemistry, and previous scientific training. Whitworth Exhibitioner (1888). Teacher of Chemistry and Physics at Evening Classes of Swinden and North Wilts Technical School.

Frank W. Harris. H. J. Phillips. C. A. Serre.
L. Archbutt. *David Howard.* *F. M. Mercer.*

Lindley, Hubert Edward,

13, St. Bartholomew Road, Camden Road, London, N.

Principal Assistant in the Laboratory of the Royal Veterinary College, London, N.W. Member of the Society of Chemical Industry. Was nearly a year apprentice to H. Buckeridge, Esq., F.I.C., F.C.S., but, owing to his death, went as Pupil Assistant to Dr. W. Johnstone, F.C.S., &c., where I was nearly three years, until I succeeded in obtaining the above at the R.V.C., where I have been nearly a year.

James Bayne. William Johnstone.
Vivian B. Lewes. C. W. Heaton.
R. H. Harland. *Percy A. E. Richards.*
Orestes V. Pisani.

Lintern, Albert Augustus, B.Sc.

High School, Middlesbrough.

Science Lecturer. Three years' experience in teaching Chemistry. Author of "Scheme of Practical Chemistry." Senior Lecturer, Middlesbrough Technical School.

Jno. Archyll Jones. C. H. Ridsdale. Alfred C. Wilson.
J. E. Stead. *William Ramsay.*

Major, George Harry,

Coldstream Street, Llanelly.

Schoolmaster (Head). Higher Grade Science and Art School, Llanelly. First Class Certificate Education Department. Holder of 10 Advanced Science Certificates (Honours, Hygiene), including First Classes in Theoretical and Practical Chemistry. Science Teacher and Lecturer for 12 years, and late Head Master of Science School, Bermondsey. Head Master of Higher Grade School and Chemical Laboratory, Llanelly. Examiner of Schools to British and Foreign School Society, London.

John J. Pilley. Gw. Evans. A. E. Barclay.
John Howard. *M. Carteighe.* *A. C. Abraham.*
Thomas Greenish.

McKerrow, William James,

c/o Hall, McKerrow & Co., Nicholas Street, Manchester.

Research Student. Doctor of Science, Tübingen. Two years in the Chemical Laboratories of the Owens College. Herr W. T. McKerrow hat im hiesigen Laboratorium den vollständigen analytischen und präparativen Uebungscurs durchgemacht. dann eine sehr tüchtige selbständige Untersuchung über Bromsilbertrages ausgeführt, auf Grund deren den Doctorgrad erwarb, und zuletzt im Sommer 1891 die Stelle eines Assistenten am Chemischen Laboratorium zu meiner vollen Zufriedenheit versehen. Ich empfehle ihn angelegentlich zur Aufnahme in die Chemische Gesellschaft.

Dr. Lothar Meyer. Harold B. Dixon. Arthur Harden.
C. Schorlemmer. G. H. Bailey.

Milnes, Ernest E.,

Ashfield, Bradford.

Demonstrator. Demonstrator in the Chemistry and Dyeing Department, Bradford Technical College; late Demonstrator Chemistry and Dyeing Department, Manchester Technical College; Lecturer on Wool Dyeing (City and Guilds) at Guiseley Mechanics' Institute.

C. Rawson. Thorp Whitaker. R. Elliot Steel.
James R. Appleyard. *Watson Smith.*

Moore, Cresacre George, B.A.,

St. Clement's Vic., Truro.

Experimental Chemist. Studied Chemistry two years at Christ Church, Oxford; took Second Class Chemistry Special, Cambridge; Assisted Mr. Lewis (Downing) in Laboratory and at C.C. Lectures; Original Work on Sewage; New Process for Production of Acetates.

Alfred Hy. Allen. A. Vernon Harcourt. Percy Elford.
Alf. W. Stokes. John J. Beringer.

Morris, Albert,
115, Hope Street, Dukinfield.

Science Teacher. Head of Albion Organised Science School; Chemical Lecturer Dukinfield Technical School; Science Teacher in Chemistry and Allied Sciences for the past six years. As Student 1st B.A. and 1st B.Sc., London University. Honours, South Kensington Science and Art Department.

J. Howard. R. L. Taylor. Joseph Morris.
W. W. Haldane Gee. C. A. Buckmaster.

Mulrenan, Joseph Charles,
45, Manor Road, Stoke Newington, N.

Science Teacher. Student for two years in Chemical and Physical Departments of Finsbury Technical College, and two years in Training College, Borough Road. At present Science Teacher in Higher Grade Schools, Wood Green.

R. Meldola. Gerald T. Moody. W. J. Pope.
J. Howard. *F. Stanley Kipping. W. P. Hatton.*

Northing, John,
96, Tritonville Road, Sandymount, Co. Dublin.

Chemist and Technical Manager, United Alkali Company (Ltd.), Sir John Rogerson's Quay, Dublin. Chemist and Technical Manager of Works; of 20 years' experience.

W. N. Hartley. Thos. A. Shegog. Chas. R. C. Tichborne.
Arthur R. Haslam. A. E. Lewis. *Thomas Byrne.*
W. E. Adeney.

Oldershaw, Frederick J.,
34, Bramhall Lane, Stockport.

Schoolmaster and Science Teacher. Science Teacher of Chemistry, Physiography, Sound, Light and Heat, Hygiene, and Mathematics at Brentnall Street Higher Grade School, Stockport. Possessor of First Class Honours, Practical Inorganic Chemistry, together with Eight First Advanced Sciences. Two years' training in studying and teaching Science at Westminster Training College. Courses in Chemistry at Owens College, Manchester; also courses in Chemistry and Metallurgy at Stockport Technical School.

Geo. A. Pingstone. R. J. Brown. G. H. Bailey.
Arthur Harden. *Gilbert J. Fowler. John J. Pilley.*

Richardson, Albert Ernest,
4, Black Hall Road, Oxford.

Undergraduate, Oxford University. Lecturer on the subjects of Chemistry and Electricity to the Oxford City Council. Studied at

Finsbury Technical College two years (holding a Saddlers' Scholarship); at the Central Institution, South Kensington, one year; and at the Oxford University three years. Associate of the Institution of Electrical Engineers.

William Odling,
Henry E. Armstrong.
V. H. Veley.
John Watts.
John Conroy.
Frederick M. Perkin.
W. W. Fisher.
J. E. Marsh.

Richardson, Reginald Edensor Stanley,

Elmfield, Knighton, Leicester.

Manufacturing Chemist. For five years at Uppingham School, under John Hinton, Esq., B.A. Oxon., Scholar Balliol College; two years under Professor Fresenius, Privy Aulic Counsellor, Professor of Chemistry, Physics, &c., Wiesbaden, Germany; also under Professor Heinrich Fresenius, Dr. Wilhelm Fresenius, and Dr. Hintz, Director of Organic Laboratories, Wiesbaden.

John Hodgkin.
Jno. Geo. Fred. Richardson.
Lewis Ough.
G. F. Schacht.
R. Fresenius.
H. N. B. Richardson.
M. Carteighe.
John Attfield.

Smith, John Meadows,

66. College Street, Chelsea, London, S.W.

Chemist. I have spent three years at the Finsbury Technical College, and obtained the Certificate in the Chemical Department; at present Chemist to British Copal Refining and Varnish Manufacturing Company.

R. Meldola. Arthur R. Ling. J. Kear Colwell.
Gerald T. Moody. W. J. Pope.

Stables, William Herbert, B.A.,

Glebe House, Kirkstall, Leeds.

Lecturer. Bachelor of Arts (Honours), Victoria. Ackroyd Scholar (Chemistry and Physics). Senior Brown Scholar (Chemistry and Physics), Yorkshire College. Prizeman and Medallist, First Class in Honours, South Kensington, &c., &c.; Research Work on the "Viscosity of Saponin." Lecturer in Chemistry and Physics, Wakefield Technical School.

T. E. Thorpe. Arthur Smithells. Herbert Ingle.
J. B. Cohen. *H. R. Procter.*

Stenhouse, James,

Tanfield, Inverleith Row, Edinburgh.

Chemist in Gas Works. Two years Student of Chemistry in

Edinburgh School of Medicine, and five years at Heriot Watt College, two years of which I was engaged in Research. Joint author with Professor Perkin of two Contributions to Trans. of the Soc. (*i.e.*), "Benzoylacetic Acid, and some of its Derivatives" (1891, 996); "The Synthetic Formation of Closed Carbon Chains," Part I (continued) (1892, 67).

J. Falconer King. W. H. Perkin, jun. A. G. Perkin.
F. Stanley Kipping. *R. Mullineux Walmsley.*

Thompson, George de Roos,

28, Treleth Road, Askam-in-Furness, Lancashire.

Analytical Chemist at the Askam and Millom Hæmatite Co., Lancashire. Analytical Chemist for three years at Morris Bros. Chemical Works, Stockwith, near Gainsborough: Works consisting of Copper Extraction, Manures, Sheep Dip, &c. A Student at the Yorkshire College, Leeds, for two years, working in the Chemical Laboratory four days per week, the rest of the time being devoted to attending Lectures on Chemistry, Physics, and Engineering. At present time is Analytical Chemist, and has been for past three years, at the Millom and Askam Hæmatite Co. Lecturer on Chemistry in the town of Askam-in-Furness, under the County Council.

Arthur Smithells. Herbert Ingle.
Charles H. Bothamley. Wm. Thos. Gent.
Julius B. Cohen.

Trobridge, Arthur,

Langley, near Birmingham.

Analytical Chemist. 18 years with Messrs. Chance Bros., Alkali Works, near Birmingham; 5½ years as Assistant Chemist; 12½ years as Sub-manager. Science and Art Department Examination (First Class Honours), 1877, in Inorganic Chemistry, &c.

T. C. Hepworth. Harry Baker.
Geo. Fred. Brindley. Edward Jackson.
E. Cleminshaw.

Tuer, Arthur Holt,

Thornhill, Wigan, Lancashire.

Analytical Chemist. Student at the Technical School and Owens College, Manchester. Assistant to Messrs. Holland & Philips, Analysts, Manchester. Chemist with Messrs. W. Blythe & Co., Church. Senior Assistant to Professor Burghardt, Analyst, Manchester. Five years Chemist with the Standish Co., Limited, near Wigan.

Philip Holland. Rowland Williams. A. B. Griffiths.
Harold Follows. Harry Baker. *John C. Watson.*

Tweedie, Thomas Shortridge,

The Moat, Annan.

Pharmaceutical Chemist. Nine months' course of Analytical Chemistry with J. Falconer King, Esq., City Analyst, Edinburgh; also nine months with Dr. Aitken, Chemist to Highland and Agricultural Society, Edinburgh.

Robert Wallace. J. Falconer King. Adam Gibson.
John Hunter. *Alex. Kinnimont.*

Wells, George Isaac James, F.I.C.,

Kinderton Lodge, Middlewich, Cheshire.

Manager of the Cheshire Alkali Company's Ammonia Soda Works Middlewich. For over 30 years has had the management of Alkali and other Chemical and Metal Extracting Works.

W. F. Lowe. J. W. Kynaston. A. Norman Tate.
Edward Davies. Alfred E. Fletcher. C. R. Alder Wright.
A. J. Greenaway.

Whalley, Lawrence John de, B.Sc.,

26, Park Place, Greenwich, S.E.

Chemist in charge, Sugar Refinery, Plaistow Wharf, Victoria Docks, E. (Messrs. Abram Lyle and Sons, Limited). Student at the Royal School of Mines and Science Schools, South Kensington, 1875–6–7, and afterwards Assistant Tutor in the Laboratories. Chemist in a Tar Works, 1¼ years. Registered Teacher in Paper Manufacture, City and Guilds of London Institute. Teacher of Chemistry.

Leonard Temple Thorne. Arthur G. Bloxam.
A. J. Greenaway. John T. Leon.
C. R. Alder Wright.

Warren, Cyprian A.,

36, The Grove, Clapham Road, S.W.

Analyst. 2 years Student at Finsbury Technical College; 3 years Student at Central Institution; 2½ years Assistant to Dr. Moritz (Chemist to the Country Brewers' Society).

Henry E. Armstrong. Gerald T. Moody. W. J. Pope.
Edwd. R. Moritz. G. Harris Morris. *Horace T. Brown.*

HARRISON AND SONS, PRINTERS IN ORDINARY TO HER MAJESTY, ST. MARTIN'S LANE.

Issued 14/5/1892.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

No. 111. Session 1892-93.

April 21st, 1892. Professor A. Crum Brown, F.R.S., President, in the Chair.

Certificates were read for the first time in favour of Messrs. John W. Alcock, Central Brewery, 45, Mott Street, Birmingham; Frederick Whiteley, B.A., 20, Dunkerley Street, Oldham.

The following paper was read:—

9. "Masrite, a new Egyptian mineral, and the possible occurrence of a new element therein." By H. Droop Richmond and Hussein Off.

The mineral in question is a variety of fibrous alum, sent to the Khedival Laboratory at Cairo by S. E. Johnson Pacha. From 1 to nearly 4 per cent. of cobalt was found in different samples. This being the first occasion on which cobalt has been met with in Egypt, the authors were led to enquire whether the blue colour used in paintings on Egyptian monuments contained that element; they were unable to detect it, however, in the samples they obtained, which owed their colour to compounds of copper and iron.

The mineral is principally interesting on account of the presence in it of a minute quantity of a substance having properties apparently unlike those of any known element, which the authors provisionally term *masrium*, from the Arabic name for Egypt.

From an analysis of the oxalate, on the assumption that it is a bivalent element, the atomic weight of "masrium" is calculated to be 228; and the authors point out that there is a vacant place in the periodic system in the glucinum-calcium group for an element having the weight 225. In many of its properties "masrium" resembles glucinum, and the oxalate is analogous to that of calcium.

Masrite has the composition

$$(Al,Fe)_2O_3\cdot(Ms,Mn,Co,Fe)O\cdot 4SO_3\cdot 20OH_2,$$

the following being the results of the analysis of one of the samples examined:—

Water	40·35
Insoluble matter	2·61
Alumina	10·62
Ferric oxide	1·63
Masric ,,	0·20
Manganous oxide	2·56
Cobaltous ,,	1·02
Ferrous ,,	4·23
Sulphuric ,,	36·78
	100·00

May 5th, 1892. Professor A. Crum Brown. F.R.S., President, in the Chair.

Certificates were read for the first time in favour of Messrs. Percy Targett Adams, Ophthalmic Hospital, Maidstone; Charles Bayliss, Selby Park, near Birmingham: Arthur Sanderson Bleckly, Thelwall Lea, near Warrington; Henry Couldong, H.M. Mint, Bombay, India; Herbert Entwistle, Crosshill Terrace, 476, Padiham Road, Bromley; John Fenton Newall, Marple, and 8, Market Place, Manchester; Charles James Norris, Skipton Grammar School; Ernest Heber Smith, 54, Cambrian View, Chester.

The following were duly elected Fellows of the Society:—Alexander Barratt; Reginald Busby Brown; George Fitz Brown; Frederick William George Blyth; Meredith Wynter Blyth; Arthur Carey; Frank Comyns, B.A; Joseph Davies; George Price Dodds; Hudson Donaldson; Walter William Duffield; Walter N. Edwards; Henry Ellison; James Fraser, F.R.S.S.A.; Haridas Gorgari, M.A.; Harold F. Hills; Henry Leonard Hinnell, A.M.I.C.E.; John Theodore Hewitt; John H. B. Jenkins; Hubert Edward Lindley; Albert Augustus Lintern, B.Sc.; George Harry Major; William James McKerrow; Ernest E. Milnes; Cresacre George Moore, B.A.; Albert Morris; Joseph Charles Mulrenan; John Northing; Albert Ernest Richardson; Reginald Edensor Stanley Richardson; John Meadows Smith; William Herbert Stables, B.A.; James Stenhouse; George de Roos Thomson; Arthur Trobridge; Arthur Holt Tuer; Thomas

Shortridge Tweedie; Cyprian A. Warren; George Isaac James Wells, F.I.C.; Lawrence John de Whalley, B.Sc.

The following extract was read from a letter to Sir Henry Roscoe, written by Professor Kühne, of Heidelberg, at the request of Professor Bunsen, who is seriously unwell:—

"*Heidelberg, April* 21*st*, 1892.

"Bunsen sent for me this morning and commissioned me to ask you to express to the Chemical Society his most sincere and hearty thanks for the much valued Address, the contents of which have gratified him highly.

"As he has always regarded the foundation of the Society, which he well remembers, as an important event of great scientific promise, so now he looks back with particular satisfaction on the fact that he has been a Fellow since its establishment, and that he has been permitted to take part in the work of the Society, especially during its earlier years, by the publication in its Transactions of many of his investigations. The allusion to this circumstance in the Address and the appreciative recognition of his scientific labours which it contains have been to him especially grateful. To his deep regret he finds himself unable to write, or, indeed, to exert any continued mental effort, and he is therefore obliged to deny himself the pleasure of personally expressing his thanks, but begs that you will ask the Society to accept them in this form."

The following papers were read:—

10. "The existence of two acetaldoximes." By Wyndham R. Dunstan and T. S. Dymond. (First notice.)

Acetaldoxime, $CH_3CH{:}NOH$, has hitherto been regarded as a liquid capable of existing only in one form, attempts to obtain evidence of the existence of an isomeride having failed; last summer, however, the authors observed that it could be crystallised. The crystals, which are acicular and often several inches long, melt at 46·5° (corr.); when they are melted and the resulting liquid is heated to 100—150°, no decomposition occurs, the boiling point (114·5°, corr.) remaining unaltered, but on cooling it does not crystallise until nearly 35° below the freezing point of the original liquid, that is at about 12° (corr.). On standing at the ordinary temperature the freezing point of this liquid gradually rises until it reaches 46·5°. The crystals which separate from the liquid at 12° are found to be the original substance melting at 46·5°.

It thus seems probable that acetaldoxime can exist in two isomeric, or, possibly, polymeric, forms. The authors propose to designate the modification melting at 46·5° *α-acetaldoxime*, whilst that which is liquid at ordinary temperatures they provisionally name *β-acetaldoxime.*

During the past six months they have been investigating the physical and chemical properties of these two modifications with the view to discovering other differences between them, but these experiments are not yet completed. This preliminary account is now given, as they wish to complete the investigation, Franchimont having recently announced that he has observed the crystallisation of acetaldoxime, and is looking for evidence of an isomeride.

Acetaldoxime may be readily prepared by the action of hydroxylamine chlorhydride on aldehyde-ammonia; the calculated quantities of these substances are mixed together and the acetaldoxime extracted from the mixture with ether. The ethereal solution is then carefully distilled in the usual manner. An almost theoretical yield is obtained.

11. "Sulphonic acids derived from anisoils (No. I)." By G. T. Moody, D.Sc.

In the course of experiments made in the Central Institution Laboratory to elucidate the manner in which isomeric sulphonic acids are formed from phenols, and especially to determine the character of the influence of the OH group, the author has had occasion to study the action of sulphonating agents on methyl and ethyl phenyl ethers. He finds that, contrary to the statement of Kekulé (*Zeit. für Chemie*, 1867, 20), and Opl and Lippmann (*Zeit. für Chemie*, 1869, 470), anisoil and phenetoil afford only parasulphonic acids.

Kahlbaum's pure preparations were employed in the experiments. The anisoil was dried over sodium and carefully distilled. It boiled constantly at 153° (uncorr.), but the first and last portions were collected apart. On shaking 50 grams of the ether with an equal volume of sulphuric acid at the ordinary temperature, it readily dissolved, heat being evolved; on adding the solution to water, however, part of the anisoil was liberated, showing that, as in the case of phenol, an intermediate compound is formed before the sulphonic acid. The anisoil thus set free was shaken with a further quantity of sulphuric acid at 80°, when complete sulphonation occurred. The products were separately converted into calcium salt, which, on evaporation of the aqueous solution, was obtained in beautiful, long, shining needles, containing 4 molecular proportions of water. The sodium salt crystallises in short, slender needles, which fall to powder on exposure to the air; the potassium salt was obtained in small scales, very soluble in water. Further quantities of the same calcium salt were obtained on fractional crystallisation of the mother liquors, but there was no indication of any other product being formed. The sulphochloride crystallises from petroleum spirit in elongated hexagonal plates melting at 40·5°; the sulphonamide melts at 108°. Sulphonation of anisoil with chlorosulphonic acid, either warm or in the cold, gave rise to the same sulphonic acid, and no other was obtained.

Phenetoil, like anisoil, on sulphonation either with sulphuric acid or with chlorosulphonic acid, either warm or in the cold, gave rise to only the para-acid, the barium salt of which has been described by Lippmann. The sodium salt forms well characterised, flat, slender, and somewhat brittle needles, and is anhydrous; the sulphochloride crystallises from light petroleum in flat, monosymmetric plates which melt at 39°, the sulphonamide forming well defined needles which melt at 150°.

12. "The formation of trithionate by the action of iodine on a mixture of sulphite and thiosulphate." By W. Spring.

In his paper on the "Investigation of the Change proceeding in an Acidified Solution of Sodium Thiosulphate," Colefax (*Chem. Soc. Trans.*, 1892, 181) credits me with having said that trithionate of sodium is produced when iodine acts on a mixture of sodium sulphite and thiosulphate, and further denies that this is the case. ("Spring's statement is not true.")

As already pointed out (*Chem. Zeitung*, **16**, 146), I never performed the experiment described by Colefax; I made use (*Bull. de l'Acad. Roy. de Belgique* [2], **38**, 1874) of potassium, and not of sodium salts; in the abstract of my paper, published in the Transactions of the German Chemical Society (**7**, 1161, 1874, and not 1873, 1108, as stated by Mr. Colefax), it is true that sodium salts are spoken of, but this is an error which is due to the fact that the proofs were not submitted to me for correction. A perusal of my original paper in the *Bull. de l'Acad. Roy. de Belgique* (*loc. cit.*) will at once convince the reader of this fact.

The difference in the behaviour of potassium and sodium salts, arising from the greater instability of the polythionates of sodium, an instability which I had already pointed out in 1874, is very striking. Hence it would appear that the strictures made by Colefax are beside the question.

However, in order to avoid any misunderstanding in future, I trust that I may be permitted to draw attention to the following facts.

Colefax has performed his experiments under modified conditions, not only as regards the substitution of sodium for potassium salts, but also as to the proportion of iodine which he has made use of. In my experiments with potassium salts, the full proportion of iodine was not used, but a much smaller quantity. The equation $K_2SO_3 + K_2S_2O_3 + I_2 = K_2S_3O_6 + 2KI$ requires less iodine than would be necessary to oxidise the sulphite to sulphate, and the hyposulphite to tetrathionate of sodium.

I have thought it desirable to ascertain whether a suitable modification of the quantity of iodine used would lead to the production of trithionate, notwithstanding the great instability of this compound, as in the case of my experiments with potassium salts, in 1874. This will explain my delay in contradicting the imputations made by Colefax.

50·4 grams of sodium sulphite, together with 49·6 grams of sodium thiosulphate, were dissolved in *iced* water, so as to avoid the decomposition of the trithionate in the subsequent action. To this solution 25·4 grams of iodine, that is, half the quantity required for complete oxidation, were added in small portions at a time. The solution was then mixed with alcohol (95°). After a few days, the well-cooled alcoholic liquid deposited a small quantity of crystals containing sodium trithionate, which was identified by suitable tests. The principal product of the action, however, was sodium sulphate.

Nevertheless, I do not contend that the formation of trithionate takes place in accordance with the equation $Na_2S_2O_3 + Na_2SO_3 + I_2 = Na_2S_3O_6 + 2NaI$.

My researches on polythionates have convinced me that sulphites have the property of desulphurising the tetrathionates, so as to convert them into trithionates. I think, in consequence, that it will be more in accordance with observed facts to admit that the sodium sulphite, which owes its existence to the employment of a reduced quantity of iodine, decomposes the small quantity of sodium tetrathionate produced in the first instance, $Na_2S_4O_6 + Na_2SO_3 = Na_2S_3O_6 + Na_2S_2O_3$. This modified interpretation deprives the interaction of the significance which I had attributed to it in 1874 with reference to the constitution of trithionic acid. I believe, however, that it is nearer to the reality.

The statement ascribed to me by Colefax, although I am not responsible for it, seems, in consequence, to be correct. It is, however, indispensable that the experiments should be performed under exactly the same conditions as those under which I operated when dealing with potassium salts.

13. "The determination of the temperature of steam arising from boiling salt solutions." By J. Sakurai.

The evidence now on record as to the temperature of the steam arising from boiling salt solutions is exceedingly unsatisfactory. Rudberg has maintained that the temperature of such steam is always the same as that of water boiling under the same pressure, but, under the conditions observed in his experiments, the temperature indicated was evidently not that of the steam, but of a film of liquid water condensed upon his thermometer bulb. Müller came to the conclusion that steam at the moment of its formation within a boiling salt solution has only the temperature of 100°, though it is more or less superheated by rising through the hot solution. Not only is this conclusion difficult to accept on theoretical grounds, but the observations on which it is based are by no means of a convincing character, and are not peculiar to salt solutions.

On the other hand, Faraday and Magnus thought they had proved that the temperature of steam escaping from a boiling salt solution is the same, or nearly the same, as that of the solution, but from the manner in which their experiments were conducted, it is not clear that the temperature they observed was really that of the natural steam escaping from a boiling solution. On the contrary, it would appear that what they determined was essentially the temperature of the wall of the vessel around the thermometer and of the steam superheated thereby.

Such being the case, the author has studied the conditions under which the true temperature of steam escaping from a boiling salt solution may be ascertained, and he has devised a method by which this can be readily effected. The result of his observations is, that *the temperature of steam escaping from a boiling salt solution is the same as that of the solution.* The most essential conditions for success are :—

1. The thermometer used in ascertaining the temperature of the steam must be kept from contact with the solution—even the smallest drops thrown up by ebullition.

2. The effect of the cooling of the thermometer by radiation must be rendered insignificant in proportion to the heating up by the steam. This condition is readily fulfilled by rapid renewal of the vapour in contact with the thermometer by the expedient of combining the introduction of steam from without with the boiling of the solution by the lamp. Ebullition alone should suffice, but the practical difficulties in the way prevent such being the case; the boiling would have to be tumultuous to generate much vapour, and in a short time the solution would become too concentrated for the experiment to be continued with convenience. On the other hand, by duly regulating the amount of steam entering from without, and the height of the flame, an abundant supply of steam can be secured, and the temperature of the boiling solution may be maintained constant within a few thousandths of a degree for any length of time.

3. The walls of that part of the vessel which serves as the steam chamber for the thermometer must be sufficiently protected from external cooling, and yet, at the same time, must not be heated to the temperature of the steam. Through the non-observance of the former condition as in Rudberg's experiments, so much of the steam is condensed in keeping the walls at 100° that it is hardly possible to keep enough passing over the thermometer bulb, while if the latter condition is ignored, as in Magnus's experiments, the indications of the thermometer may be illusory.

In the apparatus employed this last condition was secured by protecting the steam chamber with a jacket, through which passed a slow stream of the vapour generated by gentle distillation of somewhat dilute acetic acid. By modifying the degree of dilution any desired temperature, changing only slowly as distillation proceeded, was obtained in the jacket; in this manner condensation of steam upon the thermometer bulb, as well as upon the surrounding walls, was prevented.

A salt solution whose boiling point had been approximately determined and known to be higher than that of the dilute acetic acid was boiled, and a rapid current of steam introduced into the boiling solution from without. The thermometer for ascertaining the temperature of the steam now rose above that in the jacket, and ultimately attained the same temperature as the boiling solution. The following are an example of the results obtained with a solution of calcium chloride:—

Temperature of the			Difference.	
Steam.	Solution.	Acetic acid vapour.	(II)—(I).	(I)—(III).
111·2°	112·5°	110·8°	1·3	0·4
111·7	112·5	110·9	0·8	0·8
112·2	112·6	111·1	0·4	1·1
112·5	112·7	111·3	0·2	1·2
112·7	112·9	111·5	0·2	1·2
113·0	113·0	111·6	0·0	1·4
113·1	113·2	111·8	0·1	1·3
113·3	113·3	111·9	0·0	1·4

14. "Note on an observation by Gerlach of the boiling point of a solution of Glauber's salt." By J. Sakurai.

A few years ago G. T. Gerlach (*Zeit. anal. Chem.*, **26**, 413) published a paper in which he mentions that steam escaping from a boiling solution of Glauber's salt containing a crystalline magma of the anhydrous salt indicated a temperature of 100°, whilst the liquid is boiling at 82°, or even at 72°. This observation appeared to me so curious and so anomalous that I was induced to repeat his experiments: the results, on the whole, confirmed his observations as to temperatures, but, at the same time, deprived them of all exceptional character. Gerlach describes his experiments in the following words:—

"700 grams of crystallised Glauber's salt were melted in an iron vessel, and kept boiling for some time. The vessel was then removed from the lamp, and the liquid portion of its contents was poured off as completely as possible, whilst the separated anhydrous salt was left in the vessel. The whole was allowed to cool to about 50° before the vessel was again heated. This vessel was now provided with a tin-plate cover having two holes, through one of which a thermometer passed nearly reaching the bottom of the vessel, and through the other a second thermometer which hung in the steam chamber over the heated crystalline magma.

"The liquid completely boiled at 82° (Die Flussigkeit kam schon bei 82° C. vollständig in's Kochen), whilst the escaping steam showed the temperature of 100°. The temperature of the heated magma rose but very slowly, and only attained a temperature of about 100°, when the mass was almost dry.

"To this almost dry mass I added 100 grams of crystallised Glauber's salt, which melted on shaking. The crystalline magma now boiled at as low a temperature as 72° C., whilst the steam indicated 100° C." (*Loc. cit.*, 422.)

It is not correct to say that "the liquid completely boils at 82°, whilst the escaping steam has a temperature of 100°," for it is only a wet mass of anhydrous sodium sulphate that is heated. I found that steam in such a case does not uniformly arise from the heated mass, but escapes from a numbér of channels produced in those portions of it which are in contact with the sides of the vessel, and which are, therefore, most heated. The central portion of the magma, where the the thermometer bulb is placed, is more slowly heated, and hence the fact that while the steam has a temperature of 100°, the wet magma is at a lower temperature.

In the second experiment, in which some crystallised Glauber's salt is added to the heated magma, the temperature of the latter is, for a time, very much lowered, not only because a quantity of a cold substance is introduced, but also because the fusion of the crystallised salt absorbs much heat. The central portions of the mass, therefore, are at as low a temperature as 72° C., whilst the steam which rapidly forms and escapes along the sides of the vessel is at a temperature of 100°. That the latter does not exhibit a higher temperature is easy to understand from the form of the experiment. It is also needless to mention that the temperature of the whole mass soon rises.

Hence Gerlach's observations are erroneous in so far as they imply that a substance can evolve a vapour hotter than itself.

15. "Chemistry of the thioureas. Part II. (A preliminary note.)" By Emil A. Werner.

In a recent number of the *Berichte* (1892, 48), a paper appeared by A. Bertram entitled "Zur Kenntniss des Monophenylthioharnstoffs und der Imidocarbaminthiosaureester," in which an account is given of the compounds produced by the action of methyl and ethyl haloids on *monophenylthiourea.*

After referring to the several German investigators in this particular field of research, the author proceeds to describe his work, under the impression that this is the first instance in which a monosubstituted thiourea has been so studied, overlooking a paper of mine published two years ago in the Society's Transactions (1890, 283), in which an account is given of the compounds produced by the action of benzyl chloride and allyl bromide on thiourea, and its *monophenyl* and *symmetrical diphenyl* derivatives.

Since then the investigation has been continued, and the study of the action of the alkyl haloids on certain *unsymmetrical di*-substituted and *tri*-substituted derivatives of thiourea has been almost completed.

It was intended to withhold the publication of the results obtained up to the present until this branch of the investigation was rendered complete by a study of the action of the alkyl haloids on the *tetra*-substituted thioureas.

The appearance of Bertram's paper has necessitated the publication of this note, more particularly as he describes the action of methyl iodide on a tri-substituted thiourea, viz., $CS(N{\cdot}Ph{\cdot}Me)(NHPh)$. The bulk of his paper is a confirmation of my work with monophenyl thiourea already referred to, and had he been aware of my paper, the exceedingly roundabout method used by him in estimating the mercaptans produced by the decomposition of his bases, would scarcely have been described.

The following is a brief account of the more important compounds obtained during the continuation of my research, the full details of which shall be submitted to the Society at an early date.

1. *Unsymmetrical diphenyl thiourea*, $CS(NPh_2)NH_2$, produced by molecular rearrangement of diphenylamine thiocyanate.—Small needles from alcohol, m. p. 198°. Solution immediately desulphurised by $AgNO_3{\cdot}2NH_3$. The isolation of this urea completes the series of possible phenylated thioureas.

2. *Diphenyl cyanamide*, $CN{\cdot}NPh_2$, produced by desulphurisation of $CSNPh_2{\cdot}NH_2$.—Large prisms from alcohol, m. p. 73—74°. This

compound is isomeric with the diphenyl cyanamide of Weith, m. p. 292°, and with Hofmann's hexaphenylmelamine $[CN{\cdot}N(Ph)_2]_3$, m. p. above 300°.

3. *Benzyl imidodiphenylthiocarbamate*, produced by the action of $C_6H_5{\cdot}CH_2Cl$ on unsymmetrical diphenyl thiourea; m. p. 182—183°.—The base, $C_{20}H_{18}N_2S$, forms pale-yellow crystals, m. p. 125°, and has the constitution $C(NPh_2){\cdot}(NH)S{\cdot}CH_2{\cdot}Ph$.

4. *Benzyl diphenyl thiourea*, $CS(NPh{\cdot}CH_2Ph)NHPh$, from phenylthiocarbimide and benzylaniline.—Colourless crystals from alcohol, m. p. 103°. The alcoholic solution is not desulphurised by $AgNO_3{\cdot}2NH_3$, but yields a characteristic silver derivative, $CS{\cdot}NPh{\cdot}CH_2Ph{\cdot}NAgPh$, which melts at 93°, and decomposes with separation of Ag_2S at 150—160°.

5. *Benzyl phenylimidophenylbenzylthiocarbamate*, from benzyl chloride and the preceding thiourea, is a thick liquid which slowly crystallises.—The base, $C_{27}H_{24}N_2S$, is a thick, viscid, pale-yellow liquid with greenish fluorescence.

6. *Unsymmetrical phenylbenzyl thiourea*, $CS(NPh{\cdot}CH_2Ph)NH_2$, produced by molecular rearrangement of benzyl aniline thiocyanate.—It melts at 136·5°; its alcoholic solution is immediately desulphurised by $AgNO_3{\cdot}2NH_3$. The isomeric thiocyanate, $NH{\cdot}Ph{\cdot}CH_2Ph{\cdot}HCNS$, melts at 138°.

ADDITIONS TO THE LIBRARY.

I. *Donations.*

University of Nebraska: Fifth Annual Report of the Agricultural Experimental Station at Nebraska. Nebraska 1891.

From the University.

Farmyard Manure, its nature, composition and treatment, by C. M. Aikman. Edinburgh and London 1892.

Pamphlets from the Authors.

Further Notes on the Purification of Water by Metallic Iron (Anderson Process), by H. Leffmann and W. Beam. 1892.

Le Mont-Dore en 1803 et en 1891, par J. Mascarel. Clermont-Ferrand 1891.

Sulle eccezioni alle leggi dei Calori specifici, per C. E. Carbonelli. Genova 1892.

The Production of Combustible Gases, by O. Gruninger. London 1890.

Sewage Treatment, or the Purification of Water-carried Sewage, by H. L. Hinnell. Bolton 1891.

II. *By Purchase.*

The Chemistry of Paints and Painting, by A. H. Church. Second Edition. London 1892.

Water Analysis, by J. A. Wanklyn and E. T. Chapman. Eighth Edition, by J. A. Wanklyn. London 1891.

Text Book of Physiology, by M. Foster. Fifth Edition, revised. Part IV. London 1891.

Kurzes Lehrbuch der Anorganische Chemie, von F. Krafft. Leipzig und Wien 1891.

Cooley's Cyclopædia of Practical Receipts. Seventh edition, revised by W. North. 2 vols. London 1892.

Traité de Chimie appliquée aux Arts, par M. Dumas. 8 tomes. 8vo. avec Atlas en 2 tomes 4to. Paris 1828—1846.

The Radical Theory of Chemistry, by J. J. Griffin. London 1858.

The Natural History of Nitre, by W. Clarke. London 1670.

RESEARCH FUND.

A meeting of the Committee will be held in June. Fellows desiring grants are requested to make application to the Secretaries before June 15th.

At the next meeting, on May 19th, the following papers will be read :—

"The magnetic rotation of some acetyl derivatives." By Dr. Perkin.

"Note on the constitution of coloured nitro-compounds." By Dr. Armstrong.

"Studies on isomeric change. No. IV. Halogen derivatives of quinone. Part I." By A. R. Ling.

"Note on diastatic action." By E. R. Moritz and T. A. Glendinning.

"The formation of a hydrocarbon $C_{18}H_{12}$ from phenylpropionic acid." By Dr. Kipping.

HARRISON AND SONS, PRINTERS IN ORDINARY TO HER MAJESTY, ST. MARTIN'S LANE.

Issued 28/5/1892.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

No. 112. Session 1892–93.

May 19th, 1892. Professor A. Crum Brown, F.R.S., President, in the Chair.

Certificates were read for the first time in favour of Messrs. Arthur Edward Barrows, Bloomfield Iron Works, Tipton, Staffs; Horatio Ballantyne, 260, Renfrew Street, Glasgow; Thomas Cockerill, 105, Derby Street, Bolton; John Evans, Treas. R.S., Nash Mills, Hemel Hempstead; John Gibson, Ph.D., 15, Hartington Gardens, Edinburgh; Henry Ramsden Redman, 10, The Gardens, East Dulwich, S.E.

The President announced that the Council at their meeting that afternoon had adopted the following resolution expressive of the loss the Society and chemists generally had suffered by the death on May 5 of Professor von Hofmann. The resolution would be communicated to the family of the deceased and to the German Chemical Society:—

"The President and Council of the Chemical Society, at their first meeting since the death of their illustrious colleague Augustus William von Hofmann, desire to record their sense of his eminence and of the great scientific work he achieved both in England and in Germany.

"Invited to London in 1845 to organise and superintend the Royal College of Chemistry, he spent nearly twenty years in this country, and during that time made many brilliant discoveries, and trained a body of investigators who have followed his example in extending the bounds of the science and in applying chemical principles to the industrial arts.

"Many of the Fellows of the Chemical Society were introduced by him to the science, and look back with gratitude to his inspiring teaching.

"Hofmann's influence on science in this country still remains, though the country of his birth has, since 1865, received the immediate benefit of his personal labours as an investigator, teacher, and organiser.

"The President and Council of the Chemical Society of London desire to express to their colleagues of the German Chemical Society their profound sorrow at the death of the great chemist so closely connected with both, and their sympathy with the sister Society in the loss of its distinguished President."

Of the following papers those marked * were read :—

*16. "The magnetic rotation of compounds supposed to contain acetyl or of ketonic origin." By W. H. Perkin, Ph.D., F.R.S.

The author, after referring to the diverse views which are held as to the constitution of ethylic acetoacetate, draws attention to Bruhl's determination of the refractive powers of this substance, which favours a ketonic constitution, and to its magnetic rotation, which was determined several years ago by himself, and which also supports this view; a list is then given of seven acetyl compounds of which he has ascertained the magnetic rotations, all giving numbers pointing to a ketonic constitution. But as such compounds behave sometimes as ketonic and sometimes as hydroxy-derivatives, it was thought desirable to examine a larger number of compounds supposed to contain acetyl or of ketonic origin under different circumstances; the following were selected :—Pyruvic acid; levulinic acid, fused and in solution; ethylic acetonedicarboxylate; ethylic acetoacetate; acetylacetone; methylacetylacetone; ethylic β-amidocrotonate. The last-mentioned four were examined at widely different temperatures.

The rotation of the first five compounds gave numbers corresponding to a ketonic constitution, though those obtained with ethylic acetonedicarboxylate were rather high, and it is therefore proposed to re-examine this substance at higher temperatures.

The rotation of acetylacetone was found to be very high, showing it to be an unsaturated or hydroxy-compound, whilst the value obtained for methylacetylacetone stands between the hydroxy- and ketonic rotations. At temperatures approaching that of boiling water, it was found, however, that these compounds give much lower rotations than when cold: in the case of the former, the values fall between the hydroxy- and the ketonic rotations, and in the case of the latter, they nearly correspond to the ketonic rotation, showing apparently that they change into the more stable or ketonic form when heated. The refractive and dispersive powers of the same compounds, determined at different temperatures, confirmed the magnetic rotations.

The magnetic rotatory power of ethylic β-amidocrotonate was found to be remarkably high, as was its refractive and dispersive power, showing it to be an unsaturated compound; the author proposes to continue the examination of substances of this class.

DISCUSSION.

Dr. COLLIE remarked that he had long held the view that ethylic β-amidocrotonate was an imido-derivative, the correctness of which appeared to be demonstrated by Dr. Perkin's measurements.

Dr. PERKIN, in answer to Dr. Morley, said that he had not yet ascertained whether acetone was abnormally affected by heating.

*17. "The origin of colour. II. The constitution of coloured nitro-compounds." By Henry E. Armstrong.

In a communication to the Society in March, 1888 (Proceedings 1888, 27), in which the relation between colour and constitution was discussed, it was maintained that in the case of azo-dyes, the rosanilines, methylene-blue, &c., colour was conditioned by a *quinonoid* structure. Although the general correctness of this view has never yet been acknowledged, a study of the literature relating to coloured compounds which has appeared in the interval clearly shows that it is more and more recommending itself; it should also be mentioned that Nietzki, in the introduction to his *Organische Farbstoffe* (Berlin, 1889), makes reference to the quinonoid character of a number of dye-stuffs, although he does not seek to apply such a view of their structure at all generally. The subject has continually occupied my attention since I first brought it before the Society, and I think it is justifiable that I should now state the opinion at which I have arrived; viz., that in the case of coloured compounds which have been fairly well studied, it is so generally true that a quinonoid formula is applicable, that the reconsideration of the formula of any coloured substance is warrantable if it do not come within the rule. The term "*quinonoid*" must, however, be understood to include compounds of the type of benzil; and it is to be noted that in the case of closed chain compounds, it appears to be essential that at least one of the quinonoid carbon atoms be associated with a dyad radicle, and that the ring itself be unsaturated: the presence of two ortho- or para-carbonyl groups in a saturated ring apparently does not condition colour.

Nitro-compounds have from an early period attracted my attention, as they do not come within the suggested "colour-rule." It is well known, however, that nitro-compounds are not all coloured, many which are commonly described as yellow being obtained white when prepared from pure materials and precaution is taken to remove the phenolic compounds which are so frequently formed even from hydrocarbons during nitration; from this it follows that the nitro-group does not *per se* condition colour. A comparison of ortho- with para-nitrophenol affords striking confirmation of the correctness of this conclusion: the former alone is coloured, being intensely yellow, very volatile and insoluble in water; whereas paranitrophenol does not volatilise with steam, and is fairly soluble in water. To what is the difference ascribable? It can scarcely be otherwise than to a difference in structure beyond that involved in a mere difference in the relative positions of the radicles. Dr. Kipping and I, in the course of an investigation of coloured nitro-compounds in which we are engaged, have had occasion to compare the methoxynitrobenzenes prepared from ortho- and para-nitrophenol, and we find not only that they are *both* colourless, but that they agree as closely in their general properties as do most isomeric compounds containing the same radicles; it is particularly noteworthy that they are about equally volatile with steam. The non-correspondence of the two nitrophenols is rendered far more striking by the correspondence of the compounds prepared from them by methylation, and the conclusion is strengthened thereby that they are not mere position isomerides: it therefore appears justifiable to represent orthonitrophenol by a quinonoid formula, which may readily be done by transferring the hydroxylic hydrogen to the NO_2 group, thus transforming it into a dyad group, NO_2H, a change which admittedly attends the formation of so-called nitrosophenol (quinonehydroxime) (*cf.* Nietzki, *op. cit.*, p. 9). On this hypothesis, the name *quinoneorthonitroxime* may be suggested for "orthonitrophenol."

Paranitrophenol, although itself colourless, yields coloured metallic derivatives, in the formation of which a change of structure must be involved, according to the view here advocated.

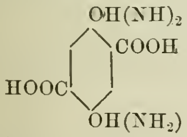
As only para- and ortho-compounds can have quinonoid formulæ, i would follow that metanitro-derivatives must be colourless; bu actually metanitraniline has an intense yellow colour. There are bu two ways out of this difficulty: to assume that metanitraniline eithe is not (as ordinarily obtained) an uniform substance, or that its struc ture is not really that of an amidonitrobenzene. There is, howeve no obvious other mode of representing it; and although Dr. Kippin and I have spent much time in trying to deprive it of its colour, w have been unsuccessful; we have found, however, that it yields practically colourless benzoate, a result which we regard as strong presumptive proof in favour of the view that metanitraniline is not what it is supposed to be, and we therefore propose to submit it and similar compounds to exhaustive study.

If it be granted that in the case of ortho- and para-nitrophenol there may be a transference of hydrogen or metal to the NO_2 group, leading to the formation of nitroximes, it is conceivable that a similar change may take place in other cases; for example, in the case of the primary nitroparaffins, the properties of which are in many respects compatible with the view that they are nitroximes. Moreover, the explanation would gain support which is afforded of the "acid" properties manifested by a compound such as benzyl cyanide, by regarding it as, at least potentially, an imide, $C_6H_5.CH{:}C{:}NH$.

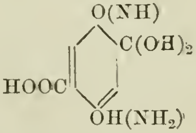
A consistent explanation of the formation of metallic derivatives could be given, and it would be unnecessary to assume that "hydrocarbon" hydrogen other than acetylenic is displaceable by metal, if the view here suggested were accepted.

*18. "The origin of colour. III. Colour as an evidence of isodynamic change: the existence of isodynamic acids." By Henry E. Armstrong.

The application of the colour-rule dwelt on in the foregoing note must lead not only to the modification of many of the formulæ attributed to coloured substances, but also to the recognition of equivalent or *isodynamic* forms (*cf.* Morley and Muir's *Watts' Dictionary of Chemistry*, **3**, Art. "Isomerism") of a variety of compounds, as I have already partially indicated. Thus it appears to me to be impossible any longer to regard the coloured substances known as paradihydroxyterephthalic acid, dihydroxypyromellithic acid and the corresponding "diamido-" acids (*cf.* Nef, *Annalen*, **237**, 38) as constituted in the manner suggested by these names, and there is no difficulty in representing them as quinonoid compounds, thereby accounting for their being coloured, thus:—



Dihydroxy- } terephthalic acid.
Diamido-



Isodynamic form of
Dihydroxy- } terephthalic acid.
Diamido-

In principle this idea is not novel (*cf.* Hantzsch and Herrmann, *Ber.*, 1887, 2800); indeed, it has already been rejected (Baeyer, *Annalen*, **245**, 189; Nef, *ibid.*, **258**, 261), but on grounds which I regard as altogether insufficient, holding, as I do, the opinion that the character of such substances is scarcely to be determined by purely chemical methods, owing to the readiness with which a change in type sets in. This is well illustrated in the case of the ethylic salts of "diamido-" terephthalic and pyromellithic acids, which are both red-coloured substances, but yield colourless salts with acids, the addition of HCl being sufficient, it would seem, to suppress the chromophoric group $C(NH){\cdot}C(OH)(OEt)$, which becomes $C(NH_2{\cdot}HCl){\cdot}COOEt$, so that in presence of acids such substances would tend to behave as amido-compounds.

If it be surmised on the evidence afforded by colour that acids exist which are not true carboxylic, but *carbhydrilic*, acids, there is no reason to deny the possible existence of such acids among colourless compounds, and it is conceivable that some of the reputed geometrically isomeric acids are of this character; von Baeyer's two hexahydroterephthalic acids perhaps afford an example of such isomerism. At present, however, we have no means of differentiating such acids from carboxylic acids.

There are a number of cases in which a suggestive explanation of peculiarities may be given with the aid of the hypothesis advocated in these notes. Thus, although orthonitromethoxybenzene is colourless when solid, the fused substance is yellow; if not due to the presence of impurity, or to slight decomposition, the appearance of colour in such a case may be conditioned by the occurrence of isodynamic change on heating. Then it is conceivable that the slight intensity of the colour exhibited by some substances may be due to the fact that the coloured and colourless isodynamic forms are both present, the coloured form in but small amount. On this view, it would be possible to understand the marked difference in intensity of colour sometimes apparent between derivatives of a coloured substance. Thus, in the case of the substituted nitrophenols, the silver derivative has frequently a much deeper colour than the potassium derivative; and the metallic derivatives of iododiorthonitrophenol are crimson, while those of the corresponding chloro-compound are bright-red; it may be that one metal more than another, and one halogen more than another, favours the occurrence of the isodynamic change on which the colour is dependent.

DISCUSSION.

Dr. ARMSTRONG, in reply to a remark by Professor Ramsay, said that although it was true that all substances exhibited absorptive power in some region of the spectrum, it was a remarkable fact that compounds which are coloured in the conventional sense clearly differ in constitution from colourless compounds, and it therefore appeared justifiable to discuss the origin of visible colour apart from the general question of absorption. It was very noteworthy that saturated compounds had but slight absorptive power even for invisible rays, and there appeared to be a connexion between the power of exercising selective absorption and what has been termed residual affinity: so much was this the case, that it appeared probable to him that ultimately colour would be traced to that peculiar condition represented conventionally by a double bond, the atoms being regarded as altogether subordinate.

*19. "Studies on isomeric change. No. IV. Halogen derivatives of quinone. Part I." By Arthur R. Ling.

Dichlorobromophenol [OH : Cl_2 : Br = 1 : 2 : 6 : 4], prepared from parabromophenol and sulphuryl chloride, crystallises from light petroleum in silky needles melting at 66·5°; it gives metadichloroquinone when treated cold with nitric acid (1·5), and a mixture of dichloroparanitrophenol (m. p. 125°) and chlororthoparadinitrophenol (m. p. 110—111°) when warmed with nitric acid in glacial acetic acid solution.

Metachlorobromoquinone [O_2 : Cl : Br = 1 : 4 : 2 : 6], prepared by adding chlorodibromophenol [OH : Cl : Br_2 = 1 : 2 : 4 : 6] to cooled nitric acid (1·5), crystallises from alcohol in yellow needles melting at 114—115°. The quinol melts at 154—155°.

Paradichlorobromoquinone [O_2 : Cl_2 : Br = 1 : 4 : 2 : 5 : 6], obtained by brominating paradichloroquinone (m. p. 161°), melts at 160—161°. The *quinol* crystallises from water in monohydrated needles melting at 124—126°; the anhydrous substance melts at 135·5°. The diacetyl derivative melts at 158—159°.

Metadibromochloroquinone [O_2 : Cl_2 : Br = 1 : 4 : 2 : 6 : 5], produced by brominating metadichloroquinone (m. p. 121°), melts at 168°. The quinol crystallises from water in anhydrous needles melting at 135°, its diacetyl derivative melting at 173—174°.

Paradichloroquinone does not yield metadichlorodibromoquinone on bromination, as stated by Hantzsch and Schniter, but the normal product—paradichlorodibromoquinone—is obtained. *Paradichlorodibromoquinone* [O_2 : Cl_2 : Br_2 = 1 : 4 : 2 : 6 : 3 : 5], produced in this way, forms six-sided plates melting at 292°; the *quinol* melts at 235—236°, its *diacetyl* derivative melting at 269—270°. The quinone does not yield chlorobromanilic acid on treatment with alkali, as Levy has stated, but a compound consisting of 1 mol. proportion of chloranilate and 2 mol. proportions of bromanilate. It is then shown that metadichloroquinone yields paradichlorodibromoquinone, identical in all respects with the last-mentioned, when it is brominated in boiling glacial acetic acid solution; when, however, the bromination is conducted at the ordinary temperature, the product consists chiefly of the normal product, metadichlorodibromoquinone.

Metadichlorodibromoquinone $[O_2 : Cl_2 : Br_2 = 1 : 4 : 2 : 6 : 3 : 5]$ is obtained exclusively when metadichlorobromoquinol (m. p. 135°) is suspended in carbon tetrachloride and heated in a closed bottle in a bath of boiling water, and the product oxidised; it crystallises from benzene in six-sided plates melting at 291°; the corresponding quinol melts at 231—232°, its diacetyl derivative melting at 265—266°. The quinone yields chlorobromanilic acid on heating it with alkali.

*20. "Halogen derivatives of quinone. Part II." By Arthur R. Ling and Julian L. Baker.

Chlorotribromoquinone, prepared by brominating monochloroquinol in acetic acid solution, and subsequently oxidising, crystallises from benzene in yellow, six-sided plates, and melts at 292°.

The formation of chlorobromanilic acid on treatment with alkali, as previously stated by one of the authors, was only observed in one experiment; in all others the *molecular compound*, $C_6ClBr(ONa)_2O_2 + 2C_6Br_2(ONa)_2O_2 + 12H_2O$, was obtained. Chlorotribromoquinol crystallises from benzene in small, colourless needles melting at 233—234°; the diacetyl derivative separates from benzene in needles melting at 275°.

Trichlorobromoquinone is obtained by brominating trichloroquinone: it separates from benzene in yellow, six-sided plates and melts at 289—290°. On treatment with soda, it yields the *compound* $C_6Cl_2(ONa)_2O_2 + 2C_6ClBr(ONa)_2O_2 + 10\frac{1}{2}H_2O$.

The formation of chlorobromanilic acid, as stated by Levy and Schultz, was not observed. Trichlorobromoquinol, prepared by reducing the quinone, crystallises from benzene in flat needles melting at 230—231°, its *diacetyl derivative* crystallising from acetic acid in colourless needles melting at 261—262°. The authors draw attention to the fact that in the interaction of the tetrahalogen quinones and alkali at least 3 mols. of the quinone appear to be simultaneously concerned (compare also preceding abstract).

*21. "The crystalline forms of the sodium derivatives of substituted anilic acids." By William J. Pope.

A comparison of the crystallographic dimensions of the sodium of the brominated and chlorinated anilic acids referred to in the preceding abstracts shows that the crystals possess considerable similarity. The salts examined crystallise in the anorthic system and have the following axial relations:—

Sodium bromanilate, $C_6(ONa)_2Br_2O_2,4H_2O$, $a : b : c = 0·8768 : 1 : 0·8100$; $\alpha = 69° 28'$; $\beta = 87° 56'$; $\gamma = 71° 49'$.

Sodium chloranilate, $C_6(ONa)_2Cl_2O_2,4H_2O$, $a : b : c = 0·8743 : 1 : ?$; $\alpha = 88° 8'$; $\beta = 89° 54'$; $\gamma = 72° 30'$.

Sodium chlorobromanilate, $C_6(ONa)_2ClBrO_2,4H_2O$, $a : b : c = 0·888 : 1 : 0·814$; $\alpha = 69° 59'$; $\beta = 87° 3'$; $\gamma = 71° 58'$.

A double salt, composed of 2 mol. proportions of sodium bromanilate and 1 of sodium chloranilate, having the composition

$$2C_6(ONa)_2Br_2O_2,4H_2O ; C_6(ONa)_2Cl_2O_2,4H_2O,$$

is obtained by the action of caustic soda on paradichlorodibromoquinone and crystallises in the anorthic system. It possesses the constants $a : b : c = 0·8825 : 1 : 0·8163$; $\alpha = 69° 48'$; $\beta = 87° 14'$; $\gamma = 72° 11'$. The same double salt, prepared by simply crystallising a mixture of the two constituents in the requisite proportions, gives numbers practically the same as these:—$a : b : c = 0·8825 : 1 : 0·8143$; $\alpha = 69° 56'$; $\beta = 87° 7'$; $\gamma = 72° 11'$. The identity of the two samples of double salt prepared in different ways is thus established. The crystals of the above substances consist of small, distorted prisms, exhibiting the forms $a\{100\}$, $b\{010\}$, $c\{001\}$, $p\{1\bar{1}0\}$ and $m\{\bar{1}01\}$. The form $m\{\bar{1}01\}$ is not met with on crystals of sodium chloranilate, so that the axial ratio $b : c$ is in this case indeterminate. It is to be remarked that the chloranilate differs considerably in angular dimensions from the salts containing bromine, which approximate very closely to one another in geometrical properties. The crystals of these salts nearly always show a curious step-like structure, which extends in the direction of the c-axis and frequently obliterates the forms $m\{\bar{1}01\}$ and $c\{001\}$ at the end of the crystal. A noteworthy fact is the great resemblance between the simple salts and the double salt of sodium brom- and chlor-anilate. The crystals of all the above-mentioned substances are, under ordinary conditions, opaque, but, when crushed to powder and examined microscopically, are seen to transmit light of a claret colour.

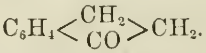
22. "Formation of a hydrocarbon, $C_{16}H_{12}$, from phenylpropionic acid." By F. Stanley Kipping, Ph.D., D.Sc.

Having studied the action of phosphoric anhydride on a number of fatty acids (*Chem. Soc. Trans.*, 1890, 532, 980), it appeared desirable to ascertain whether benzenoid acids would yield ketones under similar conditions; phenylpropionic acid was chosen. When this acid is heated with phosphoric anhydride, a reddish-brown, resinous mass is obtained; from this product I have so far succeeded in isolating three compounds, but others are doubtless formed.

1. A *hydrocarbon*, which after recrystallisation from boiling xylene, gave on analysis results corresponing to the formula C_3H_2, 0·1515 gram substance yielding 0·5250 gram CO_2 = 94·51 per cent. carbon, and 0·0710 gram H_2O = 5·21 per cent. hydrogen; the calculated values are carbon 94·74, hydrogen 5·26 per cent.

The hydrocarbon crystallises in pale-yellow plates, does not melt at 250°, and is insoluble in most ordinary solvents, and only very sparingly soluble in boiling xylene; it is evident from its properties that it has a high molecular weight, its molecular formula being probably $C_{18}H_{12}$. It dissolves in hot, concentrated sulphuric acid, yielding a sulphonic acid which is readily soluble in water. On prolonged boiling with a mixture of potassium bichromate and sulphuric acid the hydrocarbon is converted into a deep-yellow or orange compound; this substance is doubtless a *quinone* of the composition $C_{18}H_{10}O_2$, but as it is insoluble in all the ordinary solvents, and only very sparingly soluble in such liquids as boiling xylene, &c., it is not easily obtained in a pure condition; analyses gave about 1 per cent. of carbon too much, probably owing to the presence of unchanged hydrocarbon. A *dibromo*-derivative of the composition $C_{18}H_{10}Br_2$ is formed when the hydrocarbon is treated with bromine; this substance crystallises from boiling xylene in microscopic needles, and does not melt at 300°.

2. The second compound which is formed by the interaction of phosphoric anhydride and phenylpropionic acid is of greater interest than the hydrocarbon; it is, however, produced in such small quantities that up to the present I have only obtained its hydrazone in a pure condition. This *hydrazone* crystallises from dilute alcohol in yellow needles, melts at 127—128° with decomposition, and on analysis gives results agreeing well with those required by a compound of the composition $C_{15}H_{14}N_2$; when heated with concentrated hydrochloric acid it is converted into a colourless, crystalline compound which melts at about 245°, is insoluble in water and contains nitrogen. The constitution of the ketone (or aldehyde) from which this hydrazone is derived is, of course, at present quite a matter of speculation, but is possibly represented by the formula



$$C_6H_4{<}\begin{matrix}CH_2\\CO\end{matrix}{>}CH_2.$$

This view is supported by the fact that, by treating phenylpropionic acid with phosphorus pentachloride in order to convert it into the chloride $CH_2Ph{\cdot}CH_2{\cdot}COCl$, and then warming an ethereal solution of this chloride with aluminium chloride, I obtained an oil which is insoluble in sodium carbonate, and which gives with phenylhydrazine a hydrazone identical with that described above.

3. The third product obtained by the action of phosphoric anhydride on phenylpropionic acid seems to be an organic derivative of phosphoric acid.

The experiments here described are still very incomplete, but it appears desirable to call attention to them as, if ketohydrindene derivatives are really produced in this way, their investigation cannot fail to be of interest.

23. "Metallic derivatives of acetylene." By R. T. Plimpton, Ph.D.

A report in the *Chemical News* (65, 169) of a preliminary paper read by Dr. Kaiser before the Chemical Section of the Franklin Institute, on the copper and silver compounds of acetylene, leads me to publish some of the results of an investigation of these and other metallic derivatives with which I have been engaged for some time past.

1. *Silver Compounds.*

Silver Nitrate and Ammonia.—The precipitate formed by acetylene in ammoniacal silver nitrate is in dilute solutions (decinormal) bright-yellow; in strong solutions the yellow, curdy substance first thrown down is prone to pass into a white and less bulky form. The yellow substance often undergoes the same change when allowed to stand under water containing acetylene and protected from light. The white substance usually yields a somewhat higher percentage of silver. Strong ammonia appears to be without action on the yellow acetylide, and the quantity present during precipitation does not influence the composition of the precipitate.

Silver estimations in eight specimens dried over sulphuric acid gave percentages of silver ranging from 87·38 to 88·85. Of these two had been dried for three and six weeks respectively, and yielded 88·7 and 88·8. Blockmann's formula C_2Ag_2,H_2O requires 8·37; that of Berthelot, $C_2Ag_2,\frac{1}{2}H_2O$ or $(C_2HAg_2)_2O$, 86·7.

An attempt to prepare silver acetylide in neutral or acid solution, so as to diminish the risk of the precipitate carrying down with it silver oxide, was successful. Silver acetate is completely precipitated by acetylene with separation of the whole of the acetic acid. The acetylide, so prepared, has the same properties as that obtained in ammoniacal solution, but has not the same tendency to turn brownish on drying; and, like the latter, separates as a yellow, curdy precipitate, but may become white under the same conditions.

The silver was estimated in fifteen specimens carefully dried in a vacuum over sulphuric acid until they ceased to lose weight, and in some cases at 60—70°. The results lay between 86·6, the percentage of silver required for $C_2Ag_2,\frac{1}{2}H_2O$, and 87·9, nearly that required for $C_2Ag_2.\frac{1}{3}H_2O$, 87·8.

Drying at 60—70° caused a slight loss of weight, but caused the precipitates to darken. Those specimens which had become white yielded higher results than those which remained yellow. Two portions of the same precipitate, of which the one was left in contact with strong ammonia for several days, were dried and yielded the same percentage of silver, 86·56.

The acetylene given off from a known weight of the dry substance with chlorhydric acid was measured and the silver chloride weighed; ratio of silver to acetylene, as 38 to 20 or 10·3 per cent. carbon. $C_2Ag_2.\frac{1}{3}H_2O$, 9·7. Percentage of silver, 87·47. Other experiments by the same method, made with acetylide from ammoniacal silver nitrate and from silver acetate, also gave 1 mol. of acetylene to 2 atoms of silver.

Silver chloride dissolved in ammonia gave a yellow acetylide containing 87·85 per cent. silver, and free from silver chloride.

Silver nitrate, in aqueous solution (decinormal), is precipitated by acetylene, three-fourths of the acid being liberated. Precipitates prepared from solutions of different strengths contained varying proportions of silver nitrate.

Alcoholic silver nitrate yields a precipitate much richer in nitrate, containing equal amounts of silver as acetylide and as nitrate. The action of hydrocarbons of the acetylene series on alcoholic silver nitrate has been studied by Behal. My analyses of precipitates from the nitrate gave as limits $3C_2Ag_22AgNO_3Aq$ and $C_2Ag_22AgNO_3Aq$, the latter being obtained from alcoholic solutions.

Silver sulphate solutions are also completely precipitated by acetylene, and with a solution containing 0·2 gram in 100 c.c. two-thirds of the sulphuric acid was set free. Precipitates obtained from such a solution give results corresponding to $2C_2Ag_2Ag_2SO_4Aq$.

2. *Mercury Compounds.*

Mercuric acetate solutions yield white precipitates which become grey towards the end of the precipitation. If the solutions are not too strong the whole of the metal is thrown down with separation of all the acetic acid. When washed with alcohol and dried *in vacuo* over sulphuric acid the substance has the composition required by the formula $3HgO2C_2H_2$. It resembles the compound $3HgO2C_3H_43HgCl_2$, obtained by Kutcheroff (*Ber.*, **17**, 13) from allylene, for, unlike the acetylides generally, it does not give off acetylene on treatment with chlorhydric acid, and is not explosive.

Iodine attacks it, apparently, with formation of iodoform.

Mercurous acetate freshly precipitated and suspended in water is decomposed by acetylene and is converted into a greyish substance which differs entirely from the mercuric compound, and seems to be similar to silver acetylide in composition and properties. It detonates when heated suddenly, and gives acetylene on treatment with chlorhydric acid. Iodine acts upon it in the same way as upon silver acetylide, yielding di-iodacetylene.

The acetylene used was prepared from the copper compound obtained from the incomplete combustion of coal gas, and was purified by caustic soda.

I propose to continue the study of the mercurous compound and the action of iodine on this and other acetylides.

24. "Isomerism amongst the substituted thioureas." By Augustus E. Dixon, M.D.

The author notes that, while it has been established that the addition product of a thiocarbimide XNCS with a primary amine YNH_2 is identical with that resulting from the combination of the thiocarbimide YNCS with the amine XNH_2, no investigation appears, as yet, to have been conducted with the object of determining whether identical or isomeric forms would result if the substituting groups are similarly transposed in thiocarbimide and secondary amine.

In a communication recently made to the Society (*C.S. Trans.*, 1891, 551), two isomeric forms of methylphenylbenzylthiourea were incidentally described, but it was left undecided whether two ethylphenylbenzyl compounds resulting from the action of ethylthiocarbimide on benzylaniline, and of benzylthiocarbimide on ethylaniline, respectively, were identical or isomeric. Their isomerism has since been established by the observation that when heated with alcoholic ammonia, under pressure, the former yields ethylthiourea and benzylaniline, the latter benzylthiourea and ethylaniline. Furthermore, a third isomer is now described, produced from phenylthiocarbimide and ethylbenzylamine; this occurs in vitreous prisms insoluble in cold water, freely soluble in hot alcohol, chloroform, benzene and carbon disulphide, and melting at 94—95°.

An isomer of Gebhardt's (*Ber.*, **17**, 3037) dimethylphenylthiourea (m.p. 114°, from MeNCS and MeNHPh) was also obtained, by the interaction of PhNCS and Me_2NH. It forms long, white prisms, melting, without decomposition, at 134—135°. It is moderately soluble in boiling water, very freely in hot alcohol, and when boiled with aniline yields dimethylamine and thiocarbanilide.

25. "Note on diastatic action." By E. R. Moritz and T. A. Glendinning.

It has been observed by one of the authors that brewers' worts, as they issue from the mash tun, remain constant in respect to their starch transformation products when digested for two hours at the same temperature as that at which the conversion was conducted. The diastase in these solutions therefore exercises within such a period no action on the starch products contained in it; but if fresh starch be added, the residual diastase is found yet to possess considerable power of liquefying and saccharifying starch, although its energy is distinctly inferior to that of the original malt. The authors describe a series of experiments made with the object of comparing the energy of the original with that of the residual diastase.

They consider that the results entitle them to form the following conclusions:—

The attainment of a resting stage in the transformation of starch by diastase by no means shows that the energy of the diastase is exhausted. The energy of the "residual" diastase is, in fact, very considerable, even under conditions adverse to its activity. It is somewhat weakened by increasing the amount of starch it has to convert, but it is weakened to a marked extent by subjecting it for some time to a temperature exceeding the optimum one for saccharification. When, however, it is not exposed for any length of time, whether previous to the first or to subsequent transformations, to a temperature exceeding the optimum, it appears capable, after transforming a considerable amount of starch, to transform further quantities to nearly the same point, when such further quantities are added successively and subsequent to the attainment of the resting stage in the preceding transformation.

ADDITIONS TO THE LIBRARY.

I. *Donation.*

Sopra alcune proprietà del Fosforo, esperienze ed observazioni di G. Branchi. Pisa, 1813. From A. E. Sibson, Esq.

II. *By Purchase.*

An Introduction to Modern Therapeutics; being the Croonian Lectures on the Relationship between Chemical Structure and Physiological Action, by T. L. Brunton. London 1892.

Watts' Dictionary of Chemistry, revised and entirely rewritten by

H. F. Morley and M. M. P. Muir, assisted by eminent contributors. Vol. III. London 1892.

RESEARCH FUND.

A meeting of the Committee will be held in June. Fellows desiring grants are requested to make application to the Secretaries before June 9th.

At the next meeting, on June 2nd, the following papers will be read:—

"Ethylene derivatives of diazo-amido-compounds." By R. Meldola, F.R.S., and F. W. Streatfeild.

"The action of light on silver chloride." By H. Brereton Baker.

"The zymic function of yeast. I." By James O'Sullivan.

"The estimation of slag in wrought iron." By A. E. Barrows and Thomas Turner.

"The constitution of lapachic acid and its derivatives." By S. C. Hooker, Ph.D.

CERTIFICATES OF CANDIDATES FOR ELECTION AT THE NEXT BALLOT.

N.B.—The names of those who sign from "General Knowledge" are printed in *italics*.

The following Candidates will be balloted for on June 16th, 1892:—

Adams, Percy Targett,

Ophthalmic Hospital, Maidstone.

Surgeon. Diploma in Public Health, R. C. of P. and S. Lond. Student in Chemistry as applied to Sanitary Science and Food Analysis (in my father's laboratories), Maidstone.

Otto Hehner. Thos. Stevenson. Matthew A. Adams.
L. W. Stansell. Laurence Green.

Alcock, John W.,

Central Brewery, 45, Mott Street, Birmingham.

Practical Brewer and Maltster. I have been a student in the Chemistry Classes (Practical and Theoretical, Organic and Inorganic) at the Birmingham and Midland Institute for the past four years, and have passed the Science and Art Department Examinations in these subjects. My object in application for Fellowship being to further my knowledge in the chemistry in connection with my occupation.

William W. Butler. H. J. Mousley.
William McCowan. J. Cuthbert Welch.
Arthur Adams. *Thomas Turner.*

Ballantyne, Horatio,

260, Renfrew Street, Glasgow.

Analytical Chemist. For six years Assistant with R. R. Tatlock, F.R.S.E., F.I.C., F.C.S., Public Analyst for the cities of Glasgow and Perth, &c. Read paper on "The Effects of Exposure under certain conditions upon some Constants of Oils," Soc. Chem. Ind., March, 18 1 (*Journal*, p. 29, 1891). In conjunction with R. T. Thomson, F.I.C., "On the Revision of Constants employed in Oil Analysis," Part I, Soc. Chem. Ind. (*Journal*, 1890). Also "On the Revision, ditto, ditto," Part II, Soc. Chem. Ind. (*Journal*, 1891).

Robert R. Tatlock.
John Clark.
A. Humboldt Sexton.
D. A. Sutherland.
Alfred H. Allen.
G. G. Henderson.
W. MacKean.
George Watson, Junr.
Rowland Williams.

Barrows, Arthur Edward,

Bloomfield Iron Works, Tipton, Staffordshire.

Iron Manufacturer. Student for three sessions in the Metallurgical Laboratory at Mason College. Passed Senior Practical Examination. Have been engaged during the present session with Mr. Turner upon a Research on the Chemistry of Wrought Iron, the results of which will shortly be communicated to the Society.

William A. Tilden.
W. W. G. Nicol.
Thomas Turner.
Harold G. Colman.
Sidney Williamson.

Bleckly, Arthur Sanderson,

Thelwall Lea, near Warrington.

Analytical Chemist to Messrs. Pearson and Knowles' Coal and Iron Company, Limited, Warrington. Was at Polytechnicum, Hanover, Germany, for six months; also at Liverpool College of Chemistry for one term. Was then in a Works Laboratory in Middlesbrough for two years.

Thos. G. Rylands.
C. H. Ridsdale.
George Tate.
H. Wilson Hake.
Charles Willmore.
J. Rymer Young.

Bayliss, Charles,

Selly Park, near Birmingham.

Assayer and Chemist. Ten years Assayer and Chemist at the Birmingham Assay Office.

William W. Butler.
Wm. Whitehouse.
Wm. Tate.
W. W. G. Nicol.
H. J. Mousley.
Arthur Adams.
William A. Tilden.
A. Percy Smith.

Cockerill, Thomas,

105, Derby Street, Bolton.

Electrical Engineer. Engaged in the electro-deposition of metals. Had ten years' study in Electro-chemistry, and engaged in this pursuit to-day, specially in deposition of alloys. Taken Silver Medal at the City and Guilds of London Institute for this subject, and elected an Associate of the Institute of Electrical Engineers in 1891.

J. Campbell Brown. H. B. Dixon.
W. W. Haldane Gee. J. B. Cohen.
W. B. Mason. *W. Collingwood Williams.*
Charles A. Kohn.

Couldrey, Henry,

H.M. Mint. Bombay, India.

Assistant Assay Master. Studied Chemistry in the Royal College of Science, South Kensington. Assistant Assay Master in the Bombay Mint since 1873.

T. E. Thorpe. W. P. Wynne. Edwin J. Ball.
Alfred E. Tutton. William Tate.

Entwistle, Herbert,

Crosshill Terrace, 476, Padiham Road, Burnley.

Head Instructor of Burnley and District Pupil Teachers' Central Classes. (Appointed January, 1892.) From 1877 to 1884, pupil in Theoretical and Practical Chemistry (Organic and Inorganic) at Manchester Grammar School, under Francis Jones, Esq., F.R.S.E., F.C.S. In 1883 and 1884, Teacher of Theoretical and Practical Chemistry (Science and Art Department) under the Manchester School Board. In 1887 and 1888, Assistant Chemical Demonstrator to J. Howard, Esq., F.C.S., at Borough Road College, London. In 1889, 1890, 1891 and 1892 (to March), was a Science Demonstrator to the Liverpool School Board. *Commenced* the Chemistry teaching in their Schools. Had more than 100 pupils in each year in Theoretical Chemistry (Science and Art Department), and in 1891 and 1892 had nearly 100 pupils in Practical Chemistry.

Francis Jones. R. L. Taylor.
J. Howard. John Angell.
Wm. John Waterhouse. *A. Norman Tate.*
C. H. Buckmaster. *Edward Davies.*
J. Campbell Brown.

Evans, Sir John, K.C.B.,

Nash Mills, Hemel Hempstead.

President Elect of the Society of Chemical Industry. Treasurer and Vice-President of the Royal Society; D.C.L. (Oxon); LL.D. (Dublin); D.Sc. (Cambridge); Trustee of the British Museum; P.S.A., F.S.L., &c.

Alex. Crum Brown. T. E. Thorpe.
E. Frankland. Hugo Müller.
William Crookes. M. Foster.
Wyndham R. Dunstan.

Gibson, John, Ph.D., F.R.S.E., F.I.C.,

15, Hartington Gardens, Edinburgh.

Chief Assistant in the University Chemical Laboratory, Edinburgh. Chief Assistant in the University Chemical Laboratory Edinburgh since 1881. Author of numerous papers in scientific journals, among which may be mentioned—"On Laboratory Fittings," *Soc. of Chem. Ind.*, March, 1887; "Report on Physics and Chemistry of the North Sea during 1888 and 1889;" "Seventh Annual Report of Fisheries Board for Scotland;" "Report on Analytical Examination of Manganese Nodules, with special reference to the presence of the Rarer Elements," *Challenger Expedition Reports.*

Alex. Crum Brown.
William Ramsay.
T. E. Thorpe.
Henry E. Armstrong.
John Norman Collie.
John M. Thomson.

Newall, John Fenton,

Marple (also 8, Market Place, Manchester).

Merchant. I studied Chemistry under Professor Maden, at Eton, from two to three years, and have since then always had at my house a physical and chemical laboratory in which I have carried on researches in connection with my business, and with other matters not connected therewith. I have also studied Chemistry for some time in the Royal Institution Laboratory of Manchester. I am Managing Director of a large Oil Works, and have the laboratory and works under my sole control. I have also experimented a great deal in the manufacture of chemical wood pulp, and I am one of the largest dealers in that article in the kingdom.

William Thomson.
J. Carter Bell.
Alfred H. Allen.
Rowland Williams.
Thomas Fairley.
Wm. Odling.
C. Estcourt.
W. Lawrence Gadd.
S. Lees.

Norris, Charles James,

Skipton Grammar School.

Science Master in the Skipton Grammar School. Has studied Chemistry and Physics at the Royal College of Science, South Kensington.

T. E. Thorpe.
Chapman Jones.
A. E. Tutton.
C. W. Priestley.
Wllliam Tate.
Lionel M. Jones.

Redman, Henry Ramsden,

10, The Gardens, East Dulwich, S.E.

Head Master of the Stafford Street Higher Grade Schools. Formerly a student at Owens College, Manchester, and for some time Chemistry-Assistant to the Principal of Melbourne Training College. Has been engaged in teaching Chemistry during the last eight years at the Stafford Street Schools. Desirous of joining the Society in order to attend the Meetings, and to keep in touch with most recent work.

Gerald T. Moody.	W. J. Pope.
Holland Crompton.	Thos. Goddard Nicholson.
James Hendrick.	*Percy A. E. Richards.*

F. Stanley Kipping.

Smith, Ernest Heber,

54, Cambrian View, Chester.

Head Science Master, Chester Science and Art Technical Schools. Associate of Royal College of Science (London) in Chemistry. Experience as a teacher of the subject.

T. E. Thorpe.	Chapman Jones.
A. E. Tutton.	D. S. Macnair.

William R. Eaton Hodgkinson.

Whiteley, Fred., B.A., Clare College,

20, Dunkerley Street, Oldham.

Science Teacher. Student of Chemistry for the last seven years, having obtained Honours in Parts I and II of the Natural Sciences Tripos (1890 and 1891), and of late chiefly engaged in Agricultural and Analytical Chemistry in the University Chemical Laboratory, Cambridge.

Alexander Scott.	S. Ruhemann.
Thomas H. Easterfield.	G. D. Liveing.

H. J. H. Fenton.

HARRISON AND SONS, PRINTERS IN ORDINARY TO HER MAJESTY, ST. MARTIN'S LANE.

Issued 11/6/1892.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

No. 113. Session 1892–93.

June 2nd, 1892. Dr. W. H. Perkin, F.R.S., Vice-President, in the Chair.

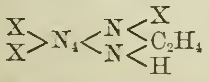
Mr. Walter N. Edwards was formally admitted a Member of the Society.

Certificates were read for the first time in favour of Messrs. Thomas Duxbury, Richmond Terrace, Darwen, Lancashire; Thomas Gray, 16, Craigmore Terrace, Dowanhill, Glasgow; Samuel C. Hooker, Philadelphia, U.S.A.; Samuel Jackson, Nether Thong, Huddersfield; Charles Spackman, Sileby, Loughborough; Frederick William Westaway, 8, Ayton Road, Stockwell, S.W.

Of the following papers those marked * were read:—

26. "Ethylene derivatives of diazoamido-compounds." By R. Meldola, F.R.S., and F. W. Streatfeild, F.I.C.

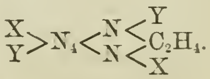
In the same way that alkyldiazoamides can be prepared by the action of alkyl haloids on diazoamides dissolved in alcohol together with the calculated quantity of potassium or sodium hydroxide (Trans., **49**, 624; **51**, 102 and 434; **53**, 664; **55**, 412; and **57**, 784), the authors find that ethylene derivatives can be obtained by the substitution of ethylene dibromide for the alkyl haloid. The products thus obtained have the general formulæ:—



$$\begin{matrix}X\\X\end{matrix}>N_4<\begin{matrix}N<X\\ \quad C_2H_4\\ N<H\end{matrix}$$

Normal ethylenediazoamide.

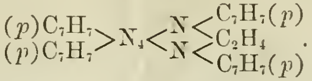
and



$$\begin{matrix}X\\Y\end{matrix}>N_4<\begin{matrix}N<Y\\ \quad C_2H_4.\\ N<X\end{matrix}$$

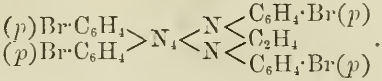
Mixed ethylenediazoamide.

In this preliminary note it is desired only to call attention to the existence of these compounds; their detailed study will be undertaken as soon as possible. The following have been thus far prepared :—



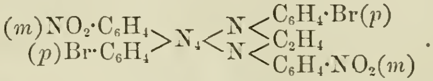
$$\begin{matrix}(p)C_7H_7\\(p)C_7H_7\end{matrix}>N_4<\begin{matrix}N<\\N<\end{matrix}\begin{matrix}C_7H_7(p)\\C_2H_4\\C_7H_7(p)\end{matrix}.$$

From diazoamido-*p*-toluene. Dull orange needles; m. p. 116—117°.



$$\begin{matrix}(p)Br\cdot C_6H_4\\(p)Br\cdot C_6H_4\end{matrix}>N_4<\begin{matrix}N<\\N<\end{matrix}\begin{matrix}C_6H_4\cdot Br(p)\\C_2H_4\\C_6H_4\cdot Br(p)\end{matrix}.$$

From diazoamido-p-bromobenzene. Yellowish-green needles; m. p. 147°.



$$\begin{matrix}(m)NO_2\cdot C_6H_4\\(p)Br\cdot C_6H_4\end{matrix}>N_4<\begin{matrix}N<\\N<\end{matrix}\begin{matrix}C_6H_4\cdot Br(p)\\C_2H_4\\C_6H_4\cdot NO_2(m)\end{matrix}.$$

From the mixed diazoamide produced by the action of diazotised metanitraniline on parabromaniline or *vice versâ*. Brownish needles, m. p. 152°.

The alkylenediazoamides are very stable, but, like the alkyl derivatives, are resolved by prolonged contact with strong chlorhydric acid at ordinary temperatures: the products of decomposition have not yet been investigated, but special interest attaches to their examination. The normal compounds may be expected to give rise to $2X\cdot N_2\cdot Cl$ and $C_2H_4<\begin{smallmatrix}NH\cdot X\\NH\cdot X\end{smallmatrix}$, and the mixed compounds to $X\cdot N_2Cl$ and $Y\cdot N_2\cdot Cl$, together with a mixed substituted ethylenediamine of the type $C_2H_4<\begin{smallmatrix}NH\cdot X\\NH\cdot Y\end{smallmatrix}$.

*27. "The action of light on silver chloride." By H. Brereton Baker, M.A.

The small loss in weight which silver chloride undergoes on exposure to light has led the author to investigate whether oxygen is absorbed at the same time that chlorine is evolved, Robert Hunt having long ago stated that such an absorption does take place. In the first experiments, silver chloride was exposed to light in a bulb connected with a long tube standing over potassium hydrate solution: a very noticeable absorption took place. Similar experiments with oxygen, instead of air, gave similar results, showing that oxygen was the gas absorbed. Attempts were then made to find in what proportions the elements silver, chlorine and oxygen were combined in the darkened substance, but so little of the dark substance was produced (less than 0·1 gram in 50 grams of unaltered chloride) that a direct analysis was found to be impossible, and an indirect method was adopted.

In the first experiments to ascertain the formula, the evolved chlorine was absorbed by potassium iodide, and the iodine which it liberated was determined; the silver was determined by treating the blackened chloride with strong ammonia and weighing the residual metal; and the oxygen by treating the dark substance with pure chlorine and measuring the oxygen evolved. The results of one such experiment were as follows:—

	Found.	Calculated for Ag_2ClO.
Ag	78·94	80·75
Cl	14·25	13·27
O............	6·81	5·98

Other experiments were made in which the oxygen absorbed and the chlorine evolved were determined in the same apparatus. The following are some of the results:—

	Oxygen absorbed.	Chlorine evolved.
I	1 atom.	0·70 atom.
II	1 ,,	1·26 atoms.
III	1 ,,	1·12 ,,
IV	1 ,,	1·26 ,,

The discrepancy of the results is attributable partly to the difficulty of working with a substance which can only be obtained in small quantities, and then in admixture with a large quantity of unaltered silver chloride; and to the fact that if the analyses are not immediately performed, the determination of the formula becomes uncertain, owing to the darkened substance turning white when kept in the dark, a fresh absorption of oxygen taking place, so that probably another oxychloride is formed.

It was found that the thoroughly-dried darkened substance, free from oxygen, gave an amount of water when reduced in pure hydrogen which corresponded to an amount of oxygen differing from that determined by other methods by less than 1 per cent.

If the darkened substance be really an oxychloride, it should not be produced in absence of oxygen. This was found to be the case, no darkening being observed in a vacuum or in carbon dioxide. Likewise no darkening was produced when silver chloride was exposed under pure dry carbon tetrachloride. It is to be noted, however, that carbon tetrachloride, unless carefully purified, contains substances, such as alcohol, carbon bisulphide, &c., which cause reduction of silver chloride and the deposition of black silver or silver sulphide, which darkening has hitherto been confounded with the darkening which takes place in air.

Lastly, when darkened silver chloride is boiled with pure potassium chloride, the whole dissolves, silver chloride being found in the solution together with potash: the production of alkali seems to prove that oxygen is present in the darkened substance in the combined state.

*28. "The estimation of slag in wrought iron." By A. E. Barrows and Thomas Turner.

It is known that in puddling cast iron comparatively rich in non-metallic elements the yield of puddled bar is greater than with less impure materials, but the loss on reheating and rolling into finished iron is also greater. It has been contended that this difference is due to intermingled slag.

The authors prepared four samples of iron, viz., best bar, best sheet from the same bar, common bar and common sheet from the same. Pig iron of known composition was used; the yield of common puddled bar was 6·5 per cent. greater than the other, but the loss in reheating was also 1·5 per cent. greater, leaving a balance of 5 per cent. in favour of the common iron. The composition of the samples was as follows:—

	Best.		Common.	
	Bar.	Sheet.	Bar.	Sheet.
Carbon	0·060	0·035	0·045	0·032
Silicon	0·228	0·168	0·275	0·221
Phosphorus	0·178	0·175	0·589	0·390

These results show that the silicon is equally, and very slightly, reduced in each case, while the phosphorus was much reduced in common iron and but scarcely affected in best. This does not favour the view that much more slag is removed in one case than the other.

The authors attempted to estimate the slag by combustion in chlorine, a method already employed by one of them for cast iron (*C.S. Trans.*, **45**, 263), but they found that the slag was attacked by the chlorine, the action taking place quite sharply at a scarely visible red heat. A considerable number of iron ores and slags were examined, and it was found that action takes place in the sense of the equation $3FeO = Fe_2O_3 + Fe$, the iron being removed by volatilisation as ferric chloride.

This action was unexpected, and, so far as the authors are aware, has not been observed before; Deville has, however, shown that when ferrous oxide is heated in hydrogen chloride, it yields magnetic oxide of iron and ferrous chloride (*Compt. rend.*, **53**, 199).

By dissolving the iron in a cold solution of sodium copper chloride, the authors have obtained the following values :—

	Best.		Common.	
	Bar.	Sheet.	Bar.	Sheet.
Slag per cent.	3·83	2·58	3·85	2·85
Loss on reheating	1·25 per cent.		1·00 per cent.	

This method requires to be further examined and checked by other processes before the results can be accepted, but they are, at least, a fairly close approximation to the truth. Though the chlorine process is not suited for slags containing iron, it appears to be correct for cast iron analysis, since the slag from the blast furnace seldom contains more than a trace of iron.

The authors conclude that for practical purposes the weight of slag in best and common iron may be taken as identical, and that on reheating and rolling each loses about the same weight of slag. The additional loss noticed on reheating impure iron is due chiefly to the elimination of phosphorus, probably in the form of ferrous phosphate.

29. "Corydaline. II." By James J. Dobbie, M.A., D.Sc., and Alexander Lauder.

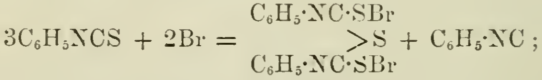
In confirmation of the formula proposed in their first paper (*C.S. Trans.*, 1892, 244), the authors give the results of analyses of the bromhydride and ethylsulphate ($C_{22}H_{29}NO_4{\cdot}C_2H_5HSO_4 + H_2O$). The latter compound is obtained by adding sulphuric acid to an alcoholic solution of corydaline, evaporating the solution to a syrupy consistency and treating with water, when crystals of the salt immediately separate out. The ethylsulphate easily dissolves in hot water, from which it crystallises, on cooling, in colourless prisms.

The alkaloid examined by the authors is identical with that obtained by Adermann (*Diss. Dorpat*, 1890; Abstr., 1891, 1266) from the roots of *Corydalis cava*, by extracting with alcohol and exhausting the alcoholic solution with benzene. The two alkaloids agree in composition, in solubility, in melting point, in their action on polarised light (dextrorotatory) and in the character of the salts which they form. On the other hand, it is quite distinct from hydroberberine, with which Adermann believed his alkaloid to be identical or, at least, isomeric.

When treated with concentrated solution of hydrogen iodide, one molecular weight of corydaline gives four molecular proportions of methyl iodide and the iodhydride of a new alkaloid which has the formula $C_{18}H_{21}NO_4,HI$. The alkaloid is obtained from this salt by the addition of ammonia or potassium hydroxide, and dissolves in excess of either agent. It possesses powerful reducing properties, and dissolves in alcohol forming a deep red-coloured solution. The conclusion that the four oxygen atoms in corydaline are united to methyl groups is confirmed by the failure to obtain any definite action with phenylhydrazine or phosphorus pentachloride.

30. "The action of bromine on allylthiocarbimide." By Augustus E. Dixon, M.D.

According to Proskauer and Sell (*Ber.*, 9, 1262), bromine and phenylthiocarbimide interact, yielding an orange-red, solid dibromide in accordance with the equation



$$3C_6H_5NCS + 2Br = \begin{matrix} C_6H_5{\cdot}NC{\cdot}SBr \\ \quad\quad > S \\ C_6H_5{\cdot}NC{\cdot}SBr \end{matrix} + C_6H_5{\cdot}NC\,;$$

and it is further stated that the action on ethyl- and allyl- thiocarbimides leads to similar results. But no data of any kind are given in support of the latter statement; the author has now investigated the case of allylthiocarbimide.

Under the conditions of his experiments, viz., operating in chloroform solution, 1 mol. bromine readily unites with 1 mol. thiocarbimide, yielding dibromopropylthiocarbimide, an oily liquid, insoluble in water, soluble in alcohol, having at 17°/17° a rel. den. of 1·9712, and decomposing on distillation at ordinary pressure.

When treated with aniline, it does not afford dibromopropylphenylthiourea, but the two substances interact with elimination of HBr, forming a compound of the formula $C_{10}H_{11}BrN_2S$, probably *n*-phenylbromotrimethylene-ψ-thiourea. This substance is insoluble in water, but soluble in alcohol; it melts at 103—104° (uncorr.), and is not desulphurised either on the addition of $AgNO_3{\cdot}2NH_3$ or by boiling with an alkaline solution of a lead salt.

31. "The hydrolytic functions of yeast. Part I." By James O'Sullivan.

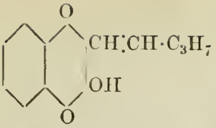
It is generally stated, on the authority of Berthelot, that the water in which yeast has been washed possesses, like yeast itself, the power of hydrolysing cane sugar, and that the active substance can be precipitated from the solution by means of alcohol. In the present communication it is is shown that *healthy* yeast yields none of its invertase to water in which it is washed; and that when it is placed in contact with sugar, hydrolysis is effected solely under the immediate influence of the plasma of the cell, no invertase leaving the cell while hydrolysis is taking place.

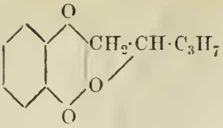
After describing his mode of obtaining a healthy yeast, the author gives an account of the difficulty met with in removing the cells from the liquid in which they were suspended; although bright liquids, free from organisms, were obtained by adding aluminium hydrate, finings or gypsum, before filtering, such substances were found to retard the activity of the invertase and therefore could not be used. Ultimately the object was obtained by shaking up the yeast and water with filter-paper pulp before filtering.

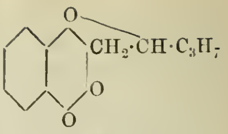
A detailed account is given of experiments carried out under various conditions, which show that water which had been in contact with highly active yeast for various times had no hydrolytic power, although on the addition of a mere trace of invertase, the solution at once became active. The author therefore concludes that the resolution of cane sugar under the influence of yeast is entirely due to zymic hydrolysis.

*32. "The constitution of lapachic acid (lapachol) and its derivatives. By Samuel C. Hooker, Ph.D.

Lapachic "acid" is found in a crystalline state in the grain of a number of South American woods, the lapacho tree, from which it derives its name, growing plentifully in the Argentine Republic; the author has obtained his material chiefly from Surinam greenheart. Paterno, in 1882, came to the conclusion that lapachic acid (lapachol) was a homonucleal *amylenehydroxynaphthaquinone*, and he subsequently expressed the view that it was an α-quinone derivative, because lapachone, a neutral isomeric substance into which it is converted by sulphuric acid, in his opinion resembled α- rather than β-naphthaquinone. The author shows that although Paterno correctly regarded lapachol as an α-quinone, his reason for doing so was wrong, as lapachone is derived from β-naphthaquinone. He proposes to term lapachone β-lapachone, to distinguish it from the isomeric, pale-yellow substance—a true α-quinone derivative—α-lapachone, which is obtained on treating lapachol with concentrated muriatic acid. The nature of the changes involved in the formation of α- and β-lapachones from lapachol is fully discussed in the paper, the formulæ assigned to them being as follows:—


(Lapachic acid) Lapachol.


α-Lapachone.


β-Lapachone.

It is shown that Paterno's isolapachone, in reality, contains less hydrogen than the lapachones, and that it is doubtless a β-naphthaquinone-propyl-furfuran.

The Society's rooms will be closed on and after June 20th, to permit of alterations, the introduction of the electric light and redecoration. It will probably be necessary to keep them closed during the entire recess.

At the next meeting, on June 16th, there will be a ballot for Foreign Members and for Fellows, and the following papers will be read :—

"Contributions to an international system of nomenclature. The nomenclature of cycloids." By Dr. Armstrong.

"The production of pyridine derivatives from the lactone of triacetic acid." By Dr. Collie and W. S. Myers.

"The resolution of lactic acid into its optically active components." By Prof. Purdie and J. W. Walker.

ERRATUM.

No. **112**, p. 112, line 6 from bottom, *for* "A. E. Sibson" *read* "Peter MacEwen."

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Issued 8/7/1892.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

No. 114. Session 1892-93.

June 16th, 1892. Professor A. Crum Brown, F.R.S., President, in the Chair.

Certificates were read for the first time in favour of Messrs. Lionel Cooper, 173, Marylebone Road, London, N.W.; James Robson, 1, Maxwell Street, Paisley, N.B.; John King Warry, 15, Grafton Street, Mile End, E.

The following were elected Fellows of the Society:—

As Foreign Members:—Emil Fischer, Würzburg; Carl Graebe, Geneva; Adolph Lieben, Vienna; Hugo Schiff, Florence; Th. Schloesing, Paris.

As Ordinary Fellows:—Percy Targett Adams, John W. Alcock, Arthur Edward Barrows, Horatio Ballantyne, Arthur Sanderson Bleckly, Charles Bayliss, Henry Conldery, Thomas Cockerill, Sir John Evans, K.C.B., Herbert Entwistle, John Gibson, Ph.D., John Fenton Newall, Charles James Norris, Henry Ramsden Redman, Ernest Heber Smith, Fred Whiteley, B.A.

Of the following papers those marked * were read:—

*33. "Contributions to an international system of nomenclature. The nomenclature of cycloids." By Henry E. Armstrong.

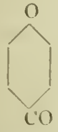
An account was given of the proceedings at the recent Conference on Chemical Nomenclature at Geneva, and attention was directed to the significance of the chief resolutions.

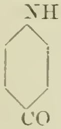
The main recommendation of the Conference may be said to be that *functional* terminations should be given to all names, *i.e.*, terminations indicative of the class to which the compound belongs. This is a principle which is familar to English chemists, through the operation of the rules laid down by the Publication Committee of the Chemical Society for the guidance of Abstractors, and one, therefore, which will readily find favour in this country.

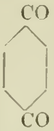
In the case of hydrocarbons, those of the paraffin series, as heretofore, are to receive names ending in *ane*. The termination *ene*, is, however, to be restricted to hydrocarbons containing carbon atoms united as in ethylene or ethene, the number of such *ethenoid* unions being indicated by a prefix, *e.g.*, propadiene = $CH_2{:}C{:}CH_2$. It is proposed that hydrocarbons containing acetylenic unions should receive names ending in *ine;* this is a somewhat unfortunate recommendation, as this termination *ine* has long been consistently applied to alkaloids by English chemists, and is an illustration of one of the difficulties met with in devising a systematic nomenclature.

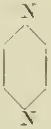
Reference was made to the discussion which arose at the Conference on the question whether carboxyl should be treated as a substituting group or no, and to the inconvenience involved in many cases in adopting the recommendation to refer acids to the hydrocarbon from which they might be regarded as derived by oxidation, a proposal which would necessitate that citric acid, for example, $CO_2H{\cdot}CH_2{\cdot}C(OH)(CO_2H){\cdot}CH_2{\cdot}CO_2H$, should be named methylpentanoltrioic acid, numbers being added to indicate the position of the OH and CO_2H groups. The motive for this recommendation is doubtless to be found in the desire to maintain a mental picture of a relationship such as exists between alcohol, aldehyde and acetic acid; but if it be remembered that only primary carbinols are convertible into corresponding aldehydes and acids on oxidation, and that there are no acids corresponding to secondary and tertiary alcohols and phenols, this argument does not appear of great weight. As *ol* is indicative of an OH derivative, there seems no reason why the simple word *acid* should not connote carboxyl, and why *al* should not connote COH; the names ethanol ethanal and ethanoic acid or simply ethane acid would then stand for the OH, COH and COOH derivatives of ethane; citric acid, on this system, would be named propanoltrioic acid or simply propanoltri-acid.

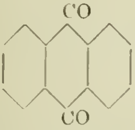
An explanation was then given at some length of the author's proposed system of nomenclature for cycloids, on which he was requested by the Conference to prepare a report. Up to the present time, the termination *ane*, applied to paraffins, has been the only one which has served to connote something more than the possession of a particular function; it has also served to convey definite information regarding the character and constitution of the compound as a whole, as definite in its way as that afforded by the term phenol applied to a particular kind of *ol* or alcohol. It is proposed to apply the term *phene* (perhaps *phen*) to all unsaturated cycloids, and *phane* (perhaps *phan*) to saturated cycloids, the number of terms or members in the cycle to be indicated by the appropriate prefix, although, probably in the case of hexaphene (benzene) derivatives, it would be unnecessary to use any prefix. For example, names such as furfuran, thiophen, pyrol, indol are purely empirical and meaningless, in no way serving to indicate the similarity in structure which obtains between the compounds to which they refer, and such names cannot be countenanced much longer; a clear idea of their structure and relationship is at once given, however, by naming such compounds respectively *oxy-* (perhaps *oxo-*), *thio-*, *azo-* and *phenazo-pentaphene.* Other examples are the following:—

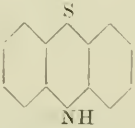

1 : 4-Oxyketophene (pyrone).


1 : 4-Imidoketophene (pyridone).

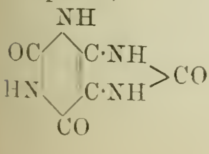

1 : 4-Diketophene (quinone).


1 : 4-Diazophene (aldine).


Dipheno-1 : 4-diketophene (anthraquinone).


Dipheno-1 : 4-thioimidophene (thiodiphenylamine).

Trimethylene, regarded as a cycloid, might be *triphane*, the name *hexaphane*, or simply *phane*, being assigned to hexamethylene instead of cyclohexane, as proposed by the Conference. The *lactones*, *imines*, *betaines*—in fact, cycloids generally, may be easily named on this same principle, thereby rendering unnecessary a number of specific terminations proposed by the Conference. Thus etheuimine, $\left.\begin{matrix}CH_2\\|\\CH_2\end{matrix}\right>NH$, is an *imidotriphane;* the lactone, $\begin{matrix}O- & & CO\\ | & & |\\ CH_2\cdot & CH_2\cdot & CH_2\end{matrix}$, is a 1 : 2-*oxyketopentaphane;* betaine, $\begin{matrix}Me_3N & - & O\\ | & & |\\ H_2C & - & CO\end{matrix}$, is *trimethazonoxyketo-tetraphane;* and uric acid, adopting the formula proposed by Medicus,



is a *diimidodiketophenodiimidoketopentaphene.*

It is proposed to discuss the subject at length in a comprehensive paper.

Discussion.

Professor Meldola, Mr. Friswell, Mr. Groves and Mr. Page all spoke in defence of trivial names, and urged the importance of retaining them. Mr. Friswell thought the use of azo to denote nitrogen in a ring might give rise to confusion, as the term had acquired significance in connexion with compounds of a different character. Mr. Page dwelt on the importance of giving new names, instead of transferring old ones, to new compounds. Professor P. F. Frankland thought names unnecessary, and that it would be better for the purposes of a register to use formulæ.

The President said that we must keep in mind that such systematic names as had been suggested were really names of formulæ rather than names of substances. Thus, a name had been suggested for uric acid on the assumption that *Medicus's formula correctly represents* the constitution of the acid. He thought it did, and so do most chemists, but some do not, and for them the name suggested will not be the name of uric acid. Again, a new substance is discovered; its discoverer has no doubt as to its constitution and gives it the corresponding name—it is written about, is used for preparing other substances, perhaps comes to be made on a large scale, but after a time it is found not to have the constitution indicated by its name: it must then get a new name, and its old name will be given to a substance *now* supposed to have the constitution it indicates. Hence will arise confusion, for when we come across the word in reading we may have some difficulty in ascertaining which substance is meant. Mr. Page gave an instance of this kind of confusion—the old hyposulphite had its name correctly enough changed to thiosulphate, but unfortunately the old name, supposed now to be free, was given to Schützenberger's salt. The best way out of *this* confusion is to abandon the name hyposulphite altogether and speak of thiosulphates and hydrosulphites. With a rigorously systematic nomenclature we should have no such resource, for the old, misapplied name would be wanted for another substance, and confusion would be unavoidable, except by adding in all such cases words sufficient to identify the substance. *These* words would then be the *name;* the systematic name would be a statement of our opinion as to the constitution. In reference to the objection to the termination -ine for hydrocarbons with an acetylene union, we could get over this by returning to the old termination -a or -ia for bases—morphia, quinia, methylia, &c. He thought that in translating the French names into English we should as far as possible drop the final *e*, and so bring our pronunciation nearer that of our brethren on the Continent. When the French nomenclature of salts was first introduced into this country, some chemists dropped the final *e* in sulphate, nitrate, &c., and, no doubt, pronouncing these words with the *a* of *hat*, not as we now do with the *a* of *hate*. The confusion would be serious with -ane, -ene, -ine, for an Englishman, unless carefully trained and warned, would be sure to pronounce -ane almost exactly as a Frenchman pronounces -ène, and -ene almost exactly as a Frenchman pronounces -ine. This would be avoided if we were to spell -an, -en, -in, for, although the pronunciation would not be identical with the French, there would be no risk of mistaking the one for the other, except perhaps in the extremest form of south English, in which -an comes so near -en as to appear almost identical to those unaccustomed to that dialect.

Mr. GROVES quoted words such as fat and fate to show that in English we could not dispense with the terminal *e*.

Dr. ARMSTRONG, in reply, said that notwithstanding its disadvantages, a system of nomenclature based on formulæ had become a necessity of the times; trivial names would necessarily still be used, but their use would probably become more and more restricted to substances in daily use. He was satisfied that within a very few years a system of nomenclature would be devised, and, therefore, it was all-important that we should contribute our due share to it, and do our best to establish as good a system as possible, adapted for use by English-speaking chemists.

*34. "The production of pyridine derivatives from the lactone of triacetic acid." By N. Collie, Ph.D., and W. S. Myers.

The authors have studied the compound obtained by the interaction of ammonia and triacetic lactone referred to by one of them in a previous communication (*C.S. Trans.*, 1891, 617); they show that most probably it is an *αγ-dihydroxy-α-picoline* rather than the imidodiketo-compound isomeric therewith. After various attempts to displace the oxygen by chlorine, they at last succeeded in effecting this by means of phosphorus oxychloride; the product possessed all the properties of a dichloropicoline, and when passed together with hydrogen over heated zinc-dust gave α-picoline boiling at 128—129°. The melting points of the platini- and auri-chlorides, and of the picrate prepared from the synthetic alkaloid, were found to be considerably higher than those noticed by former workers, but substances having the same melting points were ultimately obtained from pure α-picoline, prepared by heating pyridine methiodide. The following are the melting points observed:—

	B. p.	Platinichloride, m. p.	Aurichloride, m. p.	Picrate. m. p.
Picoline from lactone....	about 128°	216—217° (221—222° corr.)	183—184° (186—187° corr.)	169—171° (172—173° corr.)
Picoline from pyridine ..	127—129°	do.	do.	do.

The platinichloride prepared from a specimen of bone-oil picoline (b p. 128—129°), after more than 20 recrystallisations, melted at 210—211°, and the melting point could not be further raised.

*35. "The fermentation of arabinose by *Bacillus ethaceticus*." By Percy F. Frankland, F.R.S., and John MacGregor.

The products are qualitatively the same as were obtained in the fermentations of glycerol by the same organism, consisting of ethyl alcohol, acetic acid, carbon dioxide, hydrogen, and traces of succinic acid, together with another acid, which was not identified, although its carbon dioxide equivalent was determined. When, however, the fermentation is conducted in a space closed by a mercury seal instead of cotton wool, a notable proportion of formic acid also occurs amongst the products. The carbonic anhydride and hydrogen are evolved in equimolecular proportions. When the fermentation is conducted in a closed space, the products are formed approximately in the proportions $3C_2H_6O : 3C_2H_4O_2 : 4CH_2O_2$, the formic acid, as well as the carbon dioxide and hydrogen found, being all collected together as formic acid in this statement.

In the fermentations conducted in flasks plugged only with cotton wool, on the other hand, the alcohol and acetic acid were in the proportion $2C_2H_6O : 3C_2H_4O_2$. It appears therefore that in the fermentation of arabinose by *Bacillus ethaceticus* the proportion of acetic acid to alcohol is greater than in that of dextrose, and still greater than in that of mannitol and glycerol, but less than in that of glyceric acid.

*36. "Resolution of lactic acid into its optically active components." By T. Purdie, Ph.D., B.Sc., and J. Wallace Walker, M.A.

The object of the investigation described in this paper is to show by direct analytical methods that ordinary lactic acid, in accordance with the theory of Van't Hoff and Le Bel, is composed of two oppositely active constituents. Applying the method of Pasteur, which depends on the difference of solubility of the alkaloid salts of active isomeric acids, the authors have resolved ordinary lactic acid into a dextro- and a lævo-acid by means of the strychnine salt. The strychnine salts of both the active acids are crystallisable, but the strychnine lævolactate is considerably less soluble in water than its isomeride. By the fractional crystallisation of the mixed salts and the removal of the strychnine from the crystals and mother liquors by means of ammonia or barium hydrate, they obtained salt solutions which were respectively dextro- and lævo-gyrate. The dextrogyrate ammonium salt yielded a dextrogyrate zinc salt having the same composition and solubility as zinc sarcolactate. Its specific rotation, +5·63°, indicated, however, that it contained some inactive lactate. A dextrogyrate zinc ammonium salt, $C_6H_{10}O_6Zn{\cdot}C_3H_5O_3NH_4{\cdot}2H_2O$, crystallising in well-defined prisms, and having a specific rotation of about +6·49° in an $8\frac{1}{2}$ per cent. solution, was also prepared. No corresponding salt of ordinary lactic acid could be obtained. The dextrogyrate salts yielded a lævogyrate acid, which, like sarcolactic acid, yielded an oppositely active anhydride.

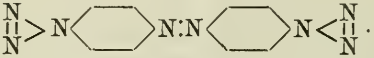
The lævogyrate salts obtained from the more soluble strychnine salts were mixed with much inactive lactate, which, however, was mostly eliminated by fractional crystallisation of the zinc salt. Lævogyrate zinc and zinc ammonium salts, similar in composition to the corresponding dextrogyrate salts were also prepared. The specific rotation of the lævogyrate zinc salt was similar in amount to that of the oppositely active isomeride, that of the zinc ammonium salt being somewhat lower, owing to the presence of inactive salt.

A special experiment proved that the quantities of oppositely active acids separated from each other by means of the strychnine salt possessed equal amounts of optical activity.

When the dextro- and lævo-gyrate zinc salts with 2 mols. of water were mixed, the less soluble inactive zinc salt was at once precipitated. Fermentation lactic acid is thus shown by analysis to consist of two oppositely active isomeric acids, one of which is identical with dextrogyrate sarcolactic acid, and the other with the lævogyrate acid obtained by Schardinger (*C.S. Abstr.*, **60**, 1891, 666) by the bacterial decomposition of cane sugar.

37. "A method for determining the number of NH_2 groups in certain organic bases." By R. Meldola, F.R.S., and E. M. Hawkins.

In the course of an investigation upon which the authors are still engaged, the question has arisen as to whether a certain base contains two NH_2 groups, or one NH_2 and one NH group. The ordinary methods of acetylating, diazotising, the formation of azo-derivatives, &c., having given ambiguous results, the authors have made experiments to ascertain whether in such cases the azoimide could be formed by Griess's method (action of ammonia on the diazoperbromide), as the determination of nitrogen in the pure product would leave no doubt as to the number of NH_2 groups which had been diazotised. As a test case they have started with the symmetrical *p*-diamidoazobenzene, $(p)NH_2\cdot C_6H_4\cdot N_2\cdot C_6H_4\cdot NH_2(p)$: this base is not easy to prepare in quantity by the methods usually described, and it was only after many experiments that they found the method patented by the Soc. Anon. des Mat. Color. de St. Denis (*Eng. Pat.*, 1579, January 29, 1890) to be the most direct, although the yield it affords is not very large. According to this method diazotised paranitraniline is combined with β-naphtholdisulphonic acid in alkaline solution (the G- and R-salts need not be separated), and the purified colouring matter is reduced by boiling with caustic soda and grape sugar. The base thus prepared was purified, diazotised in the presence of chlorhydric acid and converted into the tetrazoperbromide in the usual way. The latter, which forms an orange, crystalline powder, was allowed to remain for some hours in contact with cold dilute ammonia. The product, after several crystallisations from alcohol, forms lustrous silvery scales, melting sharply at 142°. A little above this temperature it explodes. Analysis confirmed the formula :—



Calculated.... C, 54·54; H, 3·03; N, 42·42 p. c.
Found .... C, 54·58; H, 3·33; N, 42·30 „

The substance is readily soluble in benzene, slightly soluble in petroleum, and crystallises beautifully from hot glacial acetic acid. Nitric acid or sodium nitrite added to the acetic acid solution produces an evanescent magenta-red coloration. The compound is easily reduced both by acid and alkaline reducing agents to paraphenylenediamine; the authors were unable to convert it into a diphenyl base by means of cold stannous chloride.

The method described is recommended for compounds containing NH_2 groups in different nuclei, as the azoimides are well characterised and easily crystallisable compounds. The method which is sometimes adopted, viz., the displacement of the NH_2 groups by a halogen, of course gives the same information, but in many cases this process does not work satisfactorily, and in laboratories where the vacuum method of determining nitrogen is in constant use, the determination of this element is a much simpler operation than the determination of a halogen.

38. "The existence of two acetaldoximes. Second Notice." By Wyndham R. Dunstan and T. S. Dymond.

The authors are now able to furnish further information on the change undergone by acetaldoxime when heated (*cf.* *C.S. Trans.*, 1892; *Proc.*, 1892, 89). The melting point of the pure crystals, thoroughly freed from adhering crystals by pressure between blotting-paper, is 46·5° (corr.), the determination being made in a capillary tube. When these crystals are melted and heated at 100° for a few minutes, no apparent chemical change takes place, but the liquid cannot now be crystallised until 13° (corr.). A similar change in the original substance takes place more slowly at 50°, the freezing point of the liquid gradually falling to the minimum of 13°; even at 20° this alteration slowly takes place, the crystals gradually melting and furnishing, at last, a liquid freezing at 13°. At temperatures above 100° the change is very rapid, but unless decomposition occur, the freezing point of the resulting liquid never falls below 13°, however long the heating may be continued. This liquid, on exposure at 0°, is very slowly entirely reconverted into the original aldoxime melting at 46·5°.

At first it was thought that the liquid crystallising at 13° entirely consisted of a new modification of acetaldoxime. This, however, is not the case, and so far it has not been possible to crystallise the new modification or even to obtain it in a pure state. The liquid never completely solidifies at 13°. On separating the crystals from the liquid and thoroughly drying them, they melt at 46·5°, and therefore consist of the original substance. The liquid from which these crystals were separated now freezes at a lower temperature than 13°, producing more crystals of the original substance, but on cooling the new residual liquid, the freezing point is found to have risen, and on repeating the operation, the freezing point of the separated liquids rises each time, so that by degrees the whole of the substance is obtained in its original form (m p. 46·5°).

It is therefore evident that the liquid freezing at 13° is a solution of the original hydroxime in a new liquid modification. This liquid modification cannot be obtained pure, because, on the one hand, there is a limit to the amount of it which can be produced by heating the solid, whilst on the other hand, although a somewhat stronger solution can be made by removing the crystals which separate at 13°, this operation cannot be repeated so as to produce stronger and stronger solutions and finally the pure substance, because at these low temperatures the liquid modification gradually undergoes conversion into the original aldoxime (m. p. 46·5°); and, therefore, solutions containing less and not more of the new modification are obtained.

The process by which the new acetaldoxime is formed is therefore a reversible one.

There is only a small difference (0·003) between the relative density of the original substance at its melting point and that of the solution (f. p. 13°) at the same temperature.

Determinations by Dr. Perkin of the magnetic rotations of the two liquids also exhibit only slight differences; the molecular rotation of the liquid freezing at 46·5° being 3·400 and that of the liquid freezing at 13°, 3·401.

The molecular weight of the original crystals determined by Raoult's method, using benzene as the solvent, is nearly twice as great as that corresponding with the formula C_2H_5NO (59). The same result was obtained with the solution (f. p. 13°). The two modifications, therefore, have the same molecular weight. When acetic acid is used in the determination of the molecular weight instead of benzene, both the crystals and the solution give numbers closely agreeing with that representing the weight of the gaseous moleculule C_2H_5NO.

The two modifications of acetaldoxime are therefore isomeric and not polymeric.

When acted on by acetic chloride or anhydride, acetaldoxime is stated to furnish acetonitrile and not an acetyl derivative. In the light of the observations recorded above, it seemed not unlikely that previous observations have been made with a substance consisting largely of β-acetaldoxime. Experiments have therefore been made with α-acetaldoxime (m. p. 46·5°), under such conditions that isomeric change into the β-modification cannot occur during the interaction, as it undoubtedly would if acetic chloride or anhydride were caused to act in the ordinary manner. In this way the authors have obtained what appears to be *acetyl-α-acetaldoxime.* The crystals were gradually dissolved in acetic anhydride, cooled to 0°, and after some hours the liquid was poured into a weak alkaline solution, when an oily liquid separated. This liquid cannot be crystallised, and it does not distil without decomposition. When heated with water it decomposes into acetic acid and acetaldoxime. Solid potash converts it into ammonia and acetic acid. The properties of this compound are being further investigated.

The facts now recorded demonstrate the existence of two isomeric acetaldoximes which seem to correspond in their principal properties with the two benzaldoximes, which, however, are far from stable. The isomerism of the benzaldoximes is now generally adjudged to be stereochemical: although it is probable that this is also true of the acetaldoximes, the authors consider that further experiments are needed before it can confidently be asserted that the isomerism is incapable of a structural explanation. Although it might at first seem that the small difference observed in the magnetic rotations is in harmony with the stereochemical theory, when the magnetic rotations are calculated for the possible structural formulæ, it is found that the differences are also small and are actually too slight to afford trustworthy criteria of structural isomerism.

39. "The dissociation constants of organic acids." By James Walker, D.Sc., Ph.D.

The author has determined the dissociation constants of various alkyl derivatives of pimelic acid; of dimethyl- and diethyl-pentanetetracarboxylic acids, $(HOOC)_2{\cdot}CMe{\cdot}(CH_2)_3{\cdot}CMe(COOH)_2$ and $(HOOC)_2{\cdot}CEt{\cdot}(CH_2)_3{\cdot}CEt(COOH)_2$: of several carboxyl derivatives of the polymethylenes; of citric, aconitic and tricarballylic acids; and of a number of acid ethereal salts of dibasic organic acids, $R'OOC{\cdot}R''{\cdot}COOH$. He finds that the introduction of an alkyl group into the molecule of pimelic acid has little influence on the strength of the acid, which corresponds with Walden's observations on the substituted glutaric acids. The closing of a carbon chain to form a polymethylene ring is not accompanied by any marked change in the constant. The constants of tricarballylic, aconitic and citric acids form a series parallel to that formed by the constants of succinic, fumaric and malic acids, their values being considerably greater, however, corresponding with the greater number of carboxyl groups in the molecule.

Ethyl hydrogen salts of dibasic acids have constants equal in general to about half the constants of the corresponding dihydrogen salts. Exceptions to this rule are only found in the case of dibasic acids with constants abnormally high. Methyl hydrogen salts possess constants somewhat greater than those of the corresponding ethyl hydrogen salts, so that the group COOMe has a somewhat more marked acid character than the group COOEt.

40. "Note on the preparation of alkyl iodides." By James Walker D.Sc., Ph.D.

The author describes a method for the convenient and rapid preparation of considerable quantities (500—1000 grams) of methyl or ethyl iodide from iodine, methyl or ethyl alcohol, and a mixture of red and yellow phosphorus. The apparatus employed is a modification of a fat extraction apparatus, by means of which the iodine is dissolved by the condensed alcohol or iodide, and runs into a vessel containing the phosphorus and alcohol. The method requires little attention, and gives a good yield—570 grams of ethyl iodide from

500 grams of iodine. It may also be applied to the preparation of higher iodides.

41. "An examination of the products obtained by the dry distillation of bran with lime. Preliminary communication." By W. F. Laycock, Ph.D., and F. Klingemann, Ph.D.

Considerable quantities of bran and unslaked lime, in the proportions of 1 to 2 by weight, were subjected to dry distillation. The resulting distillate consisted of a black oil floating on an aqueous solution. The aqueous solution smells of herring-brine and contains large quantities of ammonia. On boiling the solution, gases are evolved, which burn on ignition with a slightly luminous flame. Amines and furfuran are probably present.

The oil, after repeated fractionation, was found to have no constant boiling point. Analysis of different fractions showed that they all contained about 4 per cent. of nitrogen.

They were treated successively with (1) water, (2) sodium bisulphite solution (the resulting solution contained aldehydes or ketones) and (3) phenylhydrazine. The oils which remained unaffected by this treatment were distilled three times over excess of sodium and eventually fractionated. Analysis showed that the percentage of nitrogen had not been affected to any great extent, but that the substances containing oxygen had been for the greater part destroyed. The percentage of carbon was higher than in the original oil, and, judging from the behaviour of the oil towards agents, indifferent substances, probably hydrocarbons, were present. The oil is evidently a complex mixture, and fractional distillation appears to be of limited use as a means of isolating its constituents.

42. "The atomic weight of palladium." By G. H. Bailey, D.Sc., Ph.D., and Thornton Lamb.

The authors have been engaged during the past three years on the investigation of palladium salts and the redetermination of the atomic weight of palladium.

After an examination of the values obtained from various salts, especially potassium palladious chloride (the salt used by Berzelius) and the palladammonium salts, they come to the conclusion that the most reliable substance for the estimation of the atomic weight is palladammonium chloride, $Pd(NH_3Cl)_2$. They prepared a series of fractions, and determined the relation between the weight of salt taken and the palladium and chlorine obtained on reducing the compound in hydrogen. The mean of their results from the palladium is 105·46. They point out that the chlorine determinations afford far from accordant values, owing to irregularities arising in the course of the decomposition of the salt and to the difficulty of arresting the whole of the ammonium chloride. The atomic weights of all the platinum metals have now undergone revision, and it is interesting to note that the relations already pointed out by Seubert (*Liebig's Annalen*, **261**, 279) are even more pronounced when the new value is introduced in place of that obtained by Berzelius (106·35).

	Ruthenium.	Rhodium.	Palladium.	Silver.
	101·4	102·7	105·5	107·7
	Osmium.	Iridium.	Platinum.	Gold.
	190·3	192·5	194·3	196·7
Differences..	88·9	89·8	88·8	89·0

43. "The action of sulphuryl chloride on acetorthotoluidide and acetparatoluidide." By W. P. Wynne, D.Sc.

1 : 2 : 5-Metachloracetorthotoluidide is almost the sole product of the interaction of equal weights of sulphuryl chloride and acetorthotoluidide when the latter is suspended in five times its weight of carbon bisulphide. 1 : 2 : 5-Dichlorotoluene, obtained by hydrolysis of pure potassium 1 : 2 : 5-dichlorotoluenesulphonate, boils at 200° under 770 mm. pressure; on sulphonation with 10 per cent. anhydrosulphuric acid at 70—100°, this dichlorotoluene yields a single sulphonic acid, the *barium* (+ H_2O), *potassium* and *sodium* (+ $1\frac{1}{2}H_2O$) salts of which are described; the *chloride*, $C_6H_2MeCl_2{\cdot}SO_2Cl$, crystallises in large tables melting at 43°.

When acetparatoluidide, suspended in carbon bisulphide, is treated with an equal weight of sulphuryl chloride, 1 : 3 : 4-metachloracetparatoluidide is the chief product; small quantities of 1 : 3 : 4 : 5-dichloracetparatoluidide and the tri- and tetra-chloro-derivatives being also formed. The corresponding chlorotoluidines are converted into chlorotoluenes by Sandmeyer's method, and these may be separated partly by fractional distillation and partly by fractional sulphonation, since parachlorotoluene is almost exclusively sulphonated by 100 per cent. sulphuric acid, 1 : 3 : 4-dichlorotoluene by 5 per cent. anhydrosulphuric acid and 1 : 3 : 4 : 5-trichlorotoluene by 10 per cent. anhydrosulphuric acid at temperatures below 100°. 1 : 3 : 4-Dichlorotoluene, on treatment with 5 per cent. anhydrosulphuric acid, yields sulphonic acid, the *barium* (+ $2H_2O$), *potassium* and *sodium* (+ H_2O) salts of which are described; the *chloride*, $C_6H_2MeCl_2{\cdot}SO_2Cl$, crystallises in long, probably monosymmetric prisms melting at 82°. On hydrolysis of the potassium salt, pure

1 : 3 : 4-dichlorotoluene is obtained, boiling at 207° under 764 mm. pressure. 1 : 3 : 4 : 5-Trichlorotoluene, on treatment with 10 per cent. anhydrosulphuric acid, yields a single sulphonic acid, of which the *barium* (+ H_2O), *potassium* and *sodium* (+ $\frac{1}{2}H_2O$) salts are described; the *chloride*, $C_6HMeCl_3 \cdot SO_2Cl$, crystallises in short, slender needles melting at 88°. On hydrolysis of the potassium salt, 1 : 3 : 4 : 5-trichlorotoluene is obtained; this melts at 42·5°, boils at 245·5—247° under 768 mm. pressure, and, on oxidation with dilute nitric acid, yields the corresponding trichlorobenzoic acid melting at 203°.

The action of sulphuryl chloride, therefore, corresponds very closely with that of chlorine on acetortho- and acetpara-toluidide, as described by Lellmann and Klotz (*Annalen*, **231**, 310).

Orthochlorotoluene, on sulphonation with 100 per cent. sulphuric acid at 60°, seems to yield only one sulphonic acid, the *barium* (+ $2H_2O$), *potassium* (+ $\frac{1}{2}H_2O$) and *sodium* (+ $\frac{1}{2}H_2O$) salts of which are described; the *chloride*, $C_6H_3MeCl \cdot SO_2Cl$, crystallises in long, flattened, irregularly-developed prisms melting at 59°.

Metachlorotoluene, under like conditions, seems to form only one sulphonic acid, the *barium* (+ H_2O), *potassium* and *sodium* (+ H_2O) salts of which are described; the *chloride*, $C_6H_3MeCl \cdot SO_2Cl$, crystallises in brilliant, long, orthorhombic prisms melting at 53°.

Parachlorotoluene is less readily sulphonated by 100 per cent. sulphuric acid than its isomerides, and yields two isomeric sulphonic acids, which have not yet been completely separated. Two series of salts are described, one of which is beyond question derived from the mixed acids, as shown by an investigation of the sulphochloride. The results obtained agree in the main with those of Vogt and Henninger (*Ann. Chim. Phys.* [4], **27**, 130), and tend to show that the 1 : 2 : 4-isomeride, identified by conversion into the 1 : 2 : 4-parachlorotolueneorthosulphonamide described by Heffter (*Annalen*, **221**, 209), is the minor product of sulphonation.

The Society's rooms are closed until further notice, to permit of alterations, the introduction of the electric light and redecoration.

HARRISON AND SONS, PRINTERS IN ORDINARY TO HER MAJESTY, ST. MARTIN'S LAN

Issued 29/11/1892.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

No. 115. Session 1892-93.

The following are abstracts of papers received during the vacation and published in the Transactions:—

44. "Some homonucleal tri-derivatives of naphthalene (Peridibromonaphthalene)." By R. Meldola, F.R.S., and C. H. Desch (Trans., 1892, 765).

It is shown that Prager's statement (*Ber.*, 1885, 2163) that the NH_2 group in 2-nitro-4-bromo-1-amidonaphthalene cannot be displaced by bromine by Sandmeyer's method is incorrect; and a description is given of the 1 : 4-dibromo-2-nitronaphthalene, and also of the corresponding chlorobromo- and iodobromo-naphthalenes; all three substances are described as crystallising in small, *ochreous* needles melting at 117°. On reduction, they yield amines almost destitute of basic properties, which readily oxidise in air; their acetyl derivatives crystallise in white needles, bromiodo-β-acetnaphthalid melting at 235°, the chloriodo-compound at 218°.

A lengthy footnote is appended to the paper, in which the conclusion arrived at by Armstrong and Rossiter (these Proceedings, No. 104, 7, 186), that when a mixture of ortho- and para-nitracetnaphthalid is brominated, the ortho-compound is alone attacked, is corroborated; and in which the interesting statement is made that one of the authors and F. W. Streatfeild have prepared peridibromonaphthalene from 1 : 1′-nitrobromonaphthalene: this new dibromonaphthalene melts at about 109°.

45. "A method of measuring the vapour pressures of solutions." By Thomas Ewan, B.Sc., Ph.D., and W. R. Ormandy (Trans., 1892, 769).

A condensation hygrometer for determining vapour pressures of solutions at ordinary temperatures is described and figured. The hygrometer consists of a thin polished silver cup soldered to a stronger ring of brass, which in its turn is cemented into a glass tube by means of tinfoil and sulphur; the upper end of the tube is closed with a cork, through which pass a thermometer and an open tube carried down below the surface of the ether placed in the silver bulb, a side tube near the top being connected with an aspirator in such a way that the amount of air passing through the ether is under the control of the observer. The hygrometer is suspended in a glass vessel containing the solution under examination; this consists of a cylindrical bulb with a long narrow neck, a narrow side tube through which the rod of a stirrer passes being sealed into the shoulder of the bulb. The temperature is determined at which dew first becomes visible on the silver bulb.

Results obtained with solutions of sodium and cupric chloride are given in the paper.

46. "The hydrazines of quinoline." By S. F. Dufton, B.A., D.Sc. (Trans., 1892, 782).

A description is given of an improved method of nitrating quinoline, and of a variety of derivatives prepared from the ana-compound.

To nitrate quinoline, the nitrate prepared from 50 grams is added in about five portions to 50 c.c. of strong sulphuric acid contained in a litre flask, 10 c.c. of fuming sulphuric acid ($d = 2{\cdot}0$) being poured in after each introduction of nitrate, the mixture being kept cool. The yield is very good, 200 grams of ana- and 150 grams of orthonitroquinoline having been obtained from 300 grams of quinoline in one operation. A small quantity (equal to about 3 per cent. of the quinoline taken) of a dinitrohydroxyquinoline is formed; this substance very closely resembles trinitrophenol.

The compounds described are the ana-amine and hydrazine, the semicarbazide, pyruvic hydrazone, acetone-hydrazone, benzaldehydehydrazone and anaquinolinemethylpyrazolone prepared from the hydrazine and anaquinindole-α-carboxylic acid.

It is pointed out that in the case of both ortho- and ana-derivatives, one remarkable feature common to both is the intense red colour of the mon-acid salts of the amine and hydrazine. The pyruvic hydrazone separates from an aqueous solution as a bright red, crystalline precipitate differing from the corresponding ortho-compound by being soluble in water, and by its vivid colour; this, however, changes to yellow, on drying, with loss of water of crystallisation.

47. "The origin of colour (IV). Note on the appearance of colour in quinoline derivatives and of fluorescence in quinine salts." By Henry E. Armstrong (Trans., 1892, 789).

Attention is directed to the fact that it could scarcely have been predicted that the anaquinoline derivatives such as are described by Dr. Dufton would manifest colour, and it is argued that they are probably quinonoid compounds: that the appearance of colour, in fact, is conditioned by the occurrence of an isodynamic change involving the passage from the "centric" structure of quinoline to the "ethenoid" structure of a quinone. Further, it is suggested that it may eventually prove to be possible to explain the fluorescence of certain salts of quinine by the application of a similar principle.

[*Correction and Addendum.*—It is stated in the foregoing note that "The ortho-derivatives described by Dr. Dufton, excepting the pyruvic hydrazone, apparently are colourless substances." This, as Dr. Dufton has pointed out to the writer, is not the case. The mistake—an entirely inexcusable one—appears to have been made owing to the absence from Dr. Dufton's paper describing the ortho-compounds of any reference to the colour of the acid salts of the amine and hydrazine; it is only incidentally, in the paper on the ana-derivatives, that he mentions that the intense red colour of the mon-acid salts of the amine and hydrazine is a remarkable feature common to both ortho- and ana-series: although an entry of this fact was originally made when my attention was first called to the work, in writing out the "note," the descriptions of the individual compounds were apparently alone consulted, and the incidental reference to the colour of the ortho-compound was consequently overlooked.

Although at present deprived of the forcible argument which the non-appearance of colour in the ortho-series would afford, I see no reason to abandon my contention that the coloured ana-compounds are of peculiar structure. Dr. Dufton's discoveries have, in fact, added greatly to the interest attaching to the study of quinoline derivatives, and it is necessary that the ortho-derivatives should be examined with special care. So many cases are now known in which substances long regarded as uniform, definite compounds have proved to be composite that it is justifiable, in my opinion, to regard the ortho-derivatives with suspicion until their homogeneity has been placed beyond question.—H. E. A.]

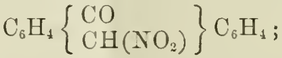
48. "Dicarboxyglutaconic acid." By S. Ruhemann, Ph.D., and R. S. Morrell (Trans., 1892, 791).

The action of phenylhydrazine on ethylic dicarboxyglutaconic acid and its benzyl derivative is shown to resemble that of ammonia, the final products being a pyrazolone derivative and ethylic malonate or benzylmalonate, the pyrazolone derivative being formed by condensation from the substituted amidoethylenedicarboxylate first produced. Phenylpyrazolone and several of its derivatives are described.

49. "Action of nitric acid on anthracene (II)." By A. G. Perkin and J. E. Mackenzie (Trans., 1892, 865).

One of the authors has previously shown that compounds of anthracene with either ethylic or methylic nitrates are formed when solutions of anthracene in ethylic or methylic alcohol are treated with nitric acid. It is now shown that the corresponding propylic, isobutylic and benzylic compounds may be prepared by using the appropriate alcohols; no corresponding product could be obtained from trimethylcarbinol, the action of nitric acid on the solution of anthracene in this alcohol giving rise to nitrosoanthrone.

Under slightly modified conditions, the action of nitric acid on anthracene dissolved in isobutylic alcohol is found to give rise to a compound which the authors regard as nitroanthrone,



$$C_6H_4\left\{\begin{matrix} CO \\ CH(NO_2) \end{matrix}\right\}C_6H_4;$$

this is converted into the isomeric nitroanthrol by treatment with alcoholic potash.

On treating anthracene dissolved in acetone (Kahlbaum's pure) with nitric acid, the compound of anthracene with methylic nitrate was produced in such quantity as to negative the assumption that it was derived from methylic alcohol present in the acetone: it would therefore seem probable that the acid acts on the acetone forming methylic nitrate and acetic acid. Using methylated ether carefully freed from alcohol, the compounds of anthracene with both ethylic and methylic nitrate were obtained.

50. "The behaviour of ethylene on explosion with less than its own volume of oxygen." By B. Lean, B.A., B.Sc., and W. A. Bone B.Sc. (Trans., 1892, 873).

After giving a brief account of previous observations, the authors describe a series of experiments in which mixtures of ethylene with its own or a less volume of oxygen were fired in a leaden coil. Their results are in agreement with those of Dalton, Kersten and E. von Meyer, and show that, when fired with about its own volume of oxygen, ethylene eventually yields mainly carbonic oxide and hydrogen; but they have also observed that methane, acetylene and carbon are produced.

The following are the tabulated results of the analyses:—

Composition of mixture.	C.	D.	E.	F.	G.
Ethylene	56·03	54·18	49·77	48·64	49·41
Oxygen	39·46	41·52	45·81	45·84	47·69
Nitrogen	4·51	4·30	4·42	5·52	2·90

Composition of product.	C.	D.	E.	F.	G.
Unsaturated hydrocarbons	5·53	3·77	2·78	2·14	—
Methane	5·96	3·77	2·52	2·55	1·01
Carbon dioxide	1·63	2·80	1·24	0·94	0·33
,, monoxide	38·85	44·84	47·79	46·53	49·11
Hydrogen...........	43·30	41·72	43·32	45·35	48·78
Nitrogen............	5·16	3·10	2·35	2·49	1·01

Incidentally it is shown that oxygen is appreciably absorbed by fuming sulphuric acid, but that neither strong potash nor alkaline pyrogallol solution appreciably affects ethylene.

51. "The lowering of the freezing points of cadmium, bismuth and lead when alloyed with other metals." By C. T. Heycock, M.A., and F. H. Neville, M.A. (Trans., 1892, 888).

The authors have considerably extended the inquiry of which they have previously given a short account (these Proceedings, No. 88). A very large number of data are recorded in the paper. From these it is apparent that the "atomic fall," *i.e.*, the ratio of the fall in freezing point of the alloy below that of the pure solvent to the number of foreign atoms present per 100 of solvent, is independent of the concentration when the solution is dilute. As the concentration increases, a gradual change takes place, however, in the atomic fall value. In a few cases, such as that of gold in cadmium or tin, and of mercury in cadmium, there is an increase in the atomic fall as the concentration increases, but in most cases the reverse is true.

The various possible causes of change in atomic fall with increasing concentration are considered, and, after calling attention to the fact that Van't Hoff's formula is strictly true only of infinitely dilute solutions, a formula applicable to finite concentrations is suggested; on the assumption that the molecule of the substance in solution contains 1 atom, the different atomic fall values corresponding to different numbers of atoms of foreign metal per 100 of solvent are calculated, and it is then pointed out that on taking a general survey of the atomic falls given in the tables in the paper and comparing them with the molecular falls predicted by the theory of osmotic pressure, it is apparent, not only that the experimental numbers are identical in a great many cases with the theoretical fall produced by a monatomic molecule, but that the experimental numbers, while often lower, *are never higher* than the theoretical number. This is an important point in favour of the osmotic theory of solution, for this theory, whilst readily explaining a low atomic fall by the hypothesis of the dissolved molecule containing more than 1 atom, assigns a superior limit, corresponding to the state in which the molecules in solution contain each 1 atom of the dissolved substance. In presence of these numbers, it seems impossible to resist the conclusion that the process of dissolution consists essentially in the disintegration of the dissolved substance and its uniform diffusion through the solvent as a gas; in other words, that the "physical theory of solution" is correct. In some cases, however, for instance that of gold dissolved in cadmium and a few others, the authors have no doubt that the molecule in solution contains atoms of both metals.

52. "Isolation of a compound of gold and cadmium." By C. T. Heycock, M.A., and F. H. Neville, M.A. (Trans., 1892, 914).

The compound has the composition represented by AuCd, and is of a greyish, silvery-white appearance, like cadmium. It was prepared by alloying gold with cadmium and moderately heating in a vacuum so long as cadmium distilled away. The immediate interest of the compound is that it confirms the supposition advanced by the authors to account for the remarkable behaviour of gold and cadmium when dissolved in tin.

53. "The resins of *Ficus rubiginosa* and *F. macrophylla*." By E. H. Rennie, D.Sc., and G. Goyder, Jun. (Trans., 1892, 916).

An account is given of the results of an examination of the resin of *F. rubiginosa* by De la Rue and Müller, contained in a paper published in the *Phil. Trans.* of 1860, and the somewhat different results of the authors are then recorded. They have separated a crystalline substance from both resins externally closely resembling De la Rue and Müller's product, but giving numbers for carbon about 3 per cent., and for hydrogen about 1 per cent. higher; the numbers are most in accordance with the formula $C_{31}H_{56}O_2$. This substance is resolved by alkaline hydrolysis into acetic acid and a crystalline substance melting at 114°, of the formula $C_{32}H_{51}O$, very closely resembling the substance described by De la Rue and Müller, which they obtained in a similar way.

54. "The hydrolytic functions of yeast. Part II." By James O'Sullivan (Trans., 1892, 926).

A further series of experiments on the hydrolytic activity of healthy yeast cells are described, the following being a summary of the conclusions arrived at:—

1. The hydrolytic action of yeast at ordinary temperatures (12° to 20° C.) follows the same course as that of a simple chemical interchange, and is not influenced by either air or carbon dioxide.

2. A time curve representing the action would correspond with that given for invertase under the most suitable conditions of acidity by O'Sullivan and Tompson (*C. S. Trans.*, 1890, **57**, 878). The rate, therefore, differs from that at which the alcoholic fermentation of yeast takes place, which would be represented by a straight line (Dumas, *Ann. Chim. Phys.* [3], 1874, 81; and A. J. Brown, *C. S. Trans.*, 1892, 384).

3. Any interference involving either an increase or a diminution of the natural acidity of the yeast cell diminishes its action. This is a very important matter, and should always be considered when dealing with organisms or cellular membranes possessing the power of hydrolysing cane sugar. Dumas observed that both acids and alkalis interfered with alcoholic fermentation, and that in the case of alkalis the yeast possessed the power of overcoming the alkalinity, the liquid again becoming acid and fermentation recommencing. It is found that a quantity of potassium hydrate which completely arrested the hydrolytic action of yeast for three to six hours was neutralised by the yeast in about 24 hours, the solutions eventually becoming acid and hydrolysis recommencing.

4. It is inferred from experiments on the effect of rupturing the cell on the velocity of the hydrolytic action, and also from the rate at which the change proceeds, that the whole of the invertase of the yeast cell comes into action as soon as the cane sugar is added to the yeast, and that it continues to act during the progress of the hydrolytic action.

5. The power which yeast possesses of producing alcoholic fermentation is not influenced by the yeast having first hydrolysed cane sugar, this being the case whether the hydrolytic action is brought about in the first instance in the presence of air or carbon dioxide.

55. "Imidosulphonates." By E. Divers and T. Haga (Trans., 1892, 943).

The authors have obtained sodium imidosulphonate for the first time and from sodium nitrite by a modification of Fremy's method of preparing the corresponding potassium salt (sulphamidate). The potassium salt is nearly insoluble in water, but the sodium salt is exceedingly soluble; and whereas the direct preparation of the former has proved to be uncertain and the yield unsatisfactory, the latter can be obtained from the nitrite almost without loss. Probably the potassium salt could be much more easily prepared than it has been were the here-described modified process adapted to its production; but the sodium salt is a much more useful agent because of its solubility, and the potassium salt can at once be prepared from it by precipitating with potassium chloride.

Sodium nitrite and sodium carbonate (crystals) in the proportions shown by the equation

$$2NaNO_2 + 3Na_2CO_3 + 8SO_2 = 2N(SO_3Na)_3 + Na_2S_2O_5 + 3CO_2$$

are placed in a flask together with a little water and a rapid stream of sulphur dioxide is passed into the magma. The flask needs to be agitated, and during the latter part of the process to be kept cool. When neutrality is approached, the gas is to be passed in more slowly, and is to be stopped just when lacmoid paper is first permanently reddened. Two salts are now present in the liquor, sodium nitrilosulphonate and metasulphite, but in a few minutes hydrolysis of the nitrilosulphonate sets in, giving disodium imidosulphonate and acid sulphate, and the latter acts on the metasulphite, forming sulphurous acid and disodium sulphate. By thus taking up the sulphuric acid, the metasulphite entirely prevents subsequent hydrolysis of the imidosulphonate into amidosulphonate. After expelling sulphur dioxide by a rapid current of air, a little sodium carbonate is added to make the liquor slightly alkaline, and enough of the water is evaporated off at a gentle heat. On cooling to near 0°, most of the sulphate crystallises and can be removed. The concentrated mother liquor affords hard, brilliant crystals of almost pure imidosulphonate; from its mother liquor more sulphate and imidosulphonate can be alternately separated. The imidosulphonate can be safely recrystallised from slightly alkaline warm water or by cold evaporation. It forms large, rhombic prisms of the composition $HN(SO_3Na)_2,(OH_2)_2$, feebly acid to litmus, which only very slowly lose water in a vacuum.

Like the potassium salt, disodium imidosulphonate is not precipitated by many of the ordinary agents, because nearly all other imidosulphonates corresponding to it are soluble. It, however, affords precipitates with sodium hydroxide, potassium chloride or nitrate, barium hydroxide, strong ammonia-water, basic lead acetate, and mercuric and mercurous nitrates; most of these act also on the dipotassium salt. Sodium hydroxide precipitates trisodium imidosulphonate; and the same salt is formed by evaporating the disodium salt with sodium carbonate, or with sodium acetate if the evaporation is repeated. Potassium chloride precipitates the dipotassium salt. Ammonia precipitates a sodium ammonium salt, and also when the solutions are very concentrated triammonium imidosulphonate; but in presence of other sodium salts, nitrate or chloride, ammonia precipitates pure trisodium imidosulphonate, leaving ammonium nitrate or chloride in solution. Baryta-water gives a barium sodium imidosulphonate.

Trisodium imidosulphonate, $NaN(SO_3Na)_2,(OH_2)_{12}$, crystallises in thin plates, sparingly soluble in cold water, freely soluble in hot water. It is a very stable salt, easy to prepare and to preserve for unlimited periods. It is an alkaline salt, and when neutralised with sulphuric acid furnishes a solution from which the disodium salt can be crystallised out. In a vacuum the crystals lose only 11 mols. of water; the other one can be expelled by heat, almost completely. A number of other imidosulphonates of corresponding composition, often double salts, can be prepared from the trisodium salt by precipitation; ammonium imidosulphonates can be also prepared from it, through the intermediation of the barium hydrogen salt, or the basic lead salt, or the silver salt.

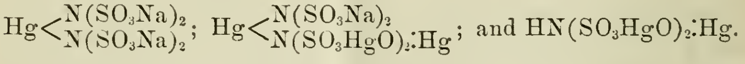
Berglund, 18 years ago, established the fact that diammonium imidosulphonate is Rose's parasulphatammon, still described in the latest English text books (Ramsay, Mendeléeff) as ammonium amidosulphonate. The authors find that dry diammonium imidosulphonate, an anhydrous salt, combines with dry ammonia to form anhydrous triammonium imidosulphonate, and that this is Rose's sulphatammon. They have also prepared in the wet way a triammonium imidosulphonate with 1 mol. of water, isomorphous with tripotassium imidosulphonate.

Barium imidosulphonate is precipitated as a voluminous matted mass of microscopic, fibrous crystals, in appearance like an organic salt. Barium hydrogen, barium ammonium, barium sodium, barium potassium imidosulphonates are all crystalline salts. Of the double calcium salts, the sodium compound may be mentioned as forming stellate groups of thick, often very brilliant, prisms.

Besides a very soluble, unstable lead hydrogen salt, a prismatic tri-hemihydroxy-lead salt, $(HOPb)_3N(SO_3)_2$, and a tetra-lead salt, $HO(HOPb)_4N(SO_3)_2$, which are both insoluble, may be obtained No double lead salts can be prepared; the hydrogen salt is known only in solution.

The interaction of trisodium imidosulphonate and silver nitrate is specially remarkable for giving in succession three strikingly different precipitates:—$AgNa_2N(SO_3)_2$, in the form of fibrous, pale yellow crystals; $Ag_2NaN(SO_3)_2$, a sparkling, white "sand" of microscopic, hexagonal crystals, all detached; and $Ag_3N(SO_3)_2$, a white precipitate, drying on the tile to chalk-like masses. The relation in composition of these three silver salts is also interesting for its rare, if not exceptional, character.

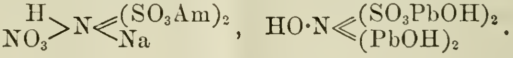
The following double mercury salts are well-defined compounds which have been examined in detail because of their interest as being at the same time sulphonic and nitrogen salts of mercury:—



$$\mathrm{Hg}{<}\begin{matrix}\mathrm{N(SO_3Na)_2}\\ \mathrm{N(SO_3Na)_2}\end{matrix};\quad \mathrm{Hg}{<}\begin{matrix}\mathrm{N(SO_3Na)_2}\\ \mathrm{N(SO_3HgO)_2{:}Hg}\end{matrix};\ \text{and } \mathrm{HN(SO_3HgO)_2{:}Hg}.$$

Neither a single mercury imidosulphonate nor any mercurous salts can be prepared. Berglund's belief in the existence of a specially stable mercury imidosulphonic acid is not confirmed by the authors' observations, for although mercury dipotassium imidosulphonate readily exchanges its potassium for barium and other metals, it keeps its potassium and exchanges its mercury for hydrogen when treated with nitric acid; and, besides, mercury hydrogen imidosulphonate is apparently less stable than imidosulphonic acid itself.

Diammonium imidosulphonate forms a double salt with sodium nitrate, and so does the dipotassium salt. The existence of these compounds and of the pentahydroxytetra-lead salt and the retention of 1 mol. of water by the trisodium salt left in a vacuum-desiccator seem to show that imidosulphonates preserve some of the power of ammonia to unite with acids and salts, the nitrogen becoming quinquevalent, thus:—



$$\begin{matrix}\mathrm{H}\\ \mathrm{NO_3}\end{matrix}{>}\mathrm{N}{<}\begin{matrix}\mathrm{(SO_3Am)_2}\\ \mathrm{Na}\end{matrix},\quad \mathrm{HO{\cdot}N}{\ll}\begin{matrix}\mathrm{(SO_3PbOH)_2}\\ \mathrm{(PbOH)_2}\end{matrix}.$$

The effect of heating ammonium and potassium imidosulphonates has been examined by previous workers, but their observations are defective. Diammonium imidosulphonate melts and boils near 357°, and flows back almost unchanged. Violent ebullition for an hour has little effect, if moisture be rigorously excluded. But the salt decomposes to a small extent like the potassium salt. Dipotassium imidosulphonate is decomposed only at the softening point of good soft lime glass into potassium sulphate, ammonia, sulphur dioxide and nitrogen. The carefully dried disodium salt behaves similarly. The trisodium salt at the same high temperature gives sodium sulphate, sulphur and nitrogen. Lead, silver and mercury salts are somewhat more easily affected by heat: in their case, besides products such as are above enumerated, mercury and even its sulphide, silver and silver sulphide, lead sulphide and sulphite are among the products. The barium salt decomposes explosively.

Anhydrous imidosulphonates of potassium or sodium, alone or with other metals, when heated to about 130° and upwards in ordinary air slowly increase in weight and become acid, being hydrolysed by the atmospheric moisture. This fact is the more interesting in that at about the same temperature amidosulphonates, heated in dry air or in a vacuum, give off ammonia and become imidosulphonates, as was first observed by Berglund.

Addendum.—*Oxyamidosulphonates.* Soon after the appearance of the authors' last paper (*J. Chem. Soc.*, **55**, 765), which treated of *oxyamidosulphonates*, Dr. Raschig wrote to request them to state on his behalf that he agreed with their account of the decomposition of these salts by caustic alkali, and wished to withdraw his own statement which had been based on qualitative observations only.

56. "Modification of Beckmann's boiling point method of determining molecular weights of substances in solution." By Joji Sakurai.

The great experimental difficulty affecting Beckmann's well-known method is the exact determination of the boiling points. A thermometer dipped into a boiling liquid always gives irregular readings, but this difficulty may be completely overcome by the method already described by the author in his paper on "The determination of the temperature of steam arising from boiling salt solutions" (*C.S. Trans.*, 1891), which consists in passing a current of the vapour of the solvent into the boiling liquid, the amount of the vapour thus passed in being regulated by the height of the lamp. The degree of constancy of the temperature attained in this manner by the boiling liquid is really astonishing, a most delicate thermometer capable of showing 1/1000th of a degree remaining almost stationary.

The apparatus used is of the simplest construction and can be set up by any one with materials commonly found in all chemical laboratories. Another advantage is that the boiling point of the solution is ascertained just before its composition is determined, the connection between these properties being, therefore, rendered more certain than in the case of Beckmann's method.

The following table (p. 152) gives an example of the results obtained.

The author confirms the statement, first made by Beckmann, that the difference in colour of iodine when dissolved in ether and in carbon bisulphide is not due to a difference in the state of its molecular aggregation, the numbers obtained for the molecular weight of iodine,

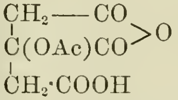
Solvent : *Ethyl Ether.*

Lat. Ht. Vap. = 90·1 (Regnault, 1862) ; b.p. = 34°·9 C. $\frac{0{\cdot}02\mathrm{T}^2}{\mathrm{W}} = 21{\cdot}0$.

Substance.	B. p.			*g* solution.	*g* substance.	*g* solvent.	*g* substance per 100 *g* solvent.	Observed molecular weight.	Diff. per 100.
	Solvent.	Solution.	Rise.						
Salicylic acid, $C_6H_4OH{\cdot}CO_2H$ = 138 ..	1·013	1·397	0·384	6·9880	0·1733	6·8147	2·513	**139·1**	+0·8
,, ..	1·337	1·661	0·324	7·2700	0·1591	7·1109	2·237	**145·0**	+5·1
,, ..	0·986	1·236	0·250	7·1381	0·1174	7·0210	1·672	**140·4**	+1·7
Naphthalene, $C_{10}H_8$ = 128	0·739	1·464	0·725	7·2743	0·3128	6·9615	4·493	**130·1**	+1·7
,, ...	1·038	1·541	0·503	7·0014	0·2143	6·7871	3·159	**131·9**	+3·0
,, ...	1·275	1·542	0·267	7·0232	0·1112	6·9120	1·609	**126·6**	−1·1
Iodine, I_2 = 254....................	1·295	1·615	0·320	7·1600	0·2678	6·8922	3·886	**255·0**	+0·4
,, ...	1·098	1·302	0·204	7·2838	0·1796	7·1042	2·528	**260·2**	+2·4
,, ...	1·174	1·255	0·081	6·9250	0·0692	6·8558	1·009	**261·6**	+3·0

when dissolved in carbon bisulphide (247·1—261·9) agreeing with those contained in the table (255·0—261·6). Beckmann's view that the molecular magnitude of sulphur in carbon bisulphide solution is represented by the formula S_8 has also received a striking confirmation in the author's hands, the numbers he obtained varying only between 252·3 and 254·9 ($S_8 = 256$).

57. "Anhydro-derivatives of citric and aconitic acids." By T. H. Easterfield and W. J. Sell.

Acetanhydrocitric acid, probably 

$$\begin{array}{l}\left.\begin{array}{l}\mathrm{CH_2{-}CO}\\ \mid\\ \mathrm{C(OAc)CO}\end{array}\right>\mathrm{O}\\ \mid\\ \mathrm{CH_2{\cdot}COOH}\end{array}$$

, prepared from anhydrous citric acid and acetic chloride, crystallises from ether in groups of short prisms melting at 115°; it decomposes at higher temperatures yielding citraconic anhydride if distilled under ordinary pressure, and itaconic anhydride when distilled under reduced pressure (30 mm.). It yields acetylcitric acid on hydrolysis; aniline converts it into citrodianilic acid; when hydrolysed by alcoholic potash it affords aconitic acid, the method being probably the best yet devised for the preparation of this acid. Ammonia converts acetanhydrocitric acid into citrazinic acid.

Aconitic anhydride may be prepared by boiling aconitic acid with excess of acetyl chloride; it crystallises out in colourless, deliquescent octahedra. On treatment with ammonia it affords citrazinic acid.

The authors were unable to obtain citrazinic acid from tricarballylic anhydride and ammonia, and point out that the formation of this acid from citric ethereal salts is probably largely dependent on the easy formation of an ethenoid union.

58. "Disubstituted semithiocarbazides." By Augustus E. Dixon, M.D.

In two former papers (Trans., 1889, 302, and 1890, 257) the author gave a short account of some members of the class of semithiocarbazides, principally with reference to the isomerism there shown to exist amongst the disubstitution derivatives. The study has since been continued, but the publication of a paper dealing with such compounds was deferred until further investigation should be made regarding a phenomenon which was frequently observed, viz., the apparent existence, for a given semithiocarbazide, of two different melting points. A communication has, however, just appeared in the *Berichte* (1892, 3098) in which this latter subject is specially dealt with; the author, therefore, desires to record, without further delay, the experimental results which he has already obtained.

Paratolylphenylsemithiocarbazide (from pToNCS and PhNH·NH$_2$) occurs as a colourless, crystalline mass, sintering at 149°; or in vitreous prisms, melting at 173—174° (uncorr.).

Phenylparatolylsemithiocarbazide (from PhNCS and pToNH·NH$_2$) occurs as a crystalline mass, sintering at 117°, and convertible, by repeated crystallisation from boiling alcohol, into feathery needles, becoming electrical on friction and melting at 172° (uncorr.). This and the preceding pair are doubtless identical with compounds described (*loc. cit.*) by Marckwald.

Orthotolylparatolylsemithiocarbazide, when prepared at a moderate temperature from oToNCS and pToNH·NH$_2$, melts at 130—131°, immediately resolidifying; on further heating, it again melts at 162—163°. The compound of m. p. 162—163° is directly obtained by combining the constituents in boiling (alcoholic) solution.

Paratolylorthotolylsemithiocarbazide, prepared from pToNCS and oToNH·NH$_2$, forms vitreous prisms melting at 141—142° (uncorr.). The formation of a compound having a lower melting point was not observed.

Diorthotolylsemithiocarbazide.—Brilliant, colourless octahedra, melting at 148—149° (uncorr.).

Diparatolylsemithiocarbazide.—If prepared in gently-warmed alcoholic solution, forms aggregates of flattened crystals, melting at about 125°, but at once resolidifying and then melting at or near 153°. By mixing boiling alcoholic solutions of the constituents, the substance is obtained in pointed prisms melting at 153—154° (uncorr.).

Alphanaphthylphenylsemithiocarbazide (from α-NapNCS and PhNH·NH$_2$).—Brilliant, vitreous needles, melting at 183° (uncorr.). Isomeric with Freund's (*Ber.*, **24**, 4190) phenyl-α-naphthyl derivative melting at 135°.

Phenylbetanaphthylsemithiocarbazide, prepared from PhNCS and β-NapNH·NH$_2$, forms pearly needles, melting at 184—184·5° (uncorr.). According to Freund (*loc. cit.*) this substance melts at 202°.

Betanaphthylphenylsemithiocarbazide, prepared from β-NapNCS and PhNH·NH$_2$, crystallises in silvery needles, melting at 190—191° (uncorr.).

Benzylphenylsemithiocarbazide.—White, flexible prisms; m. p. 115—116° (uncorr.). On heating in alcoholic solution with a trace of chlorhydric acid the m. p. rises to 163°.

Benzylparatolylsemithiocarbazide.—Shining, flattened prisms; m. p. 120—121° (uncorr.).

59. "Studies on the interaction of bromine and toluene. Preparation and properties of ortho- and para-bromotoluene, and of the dibromotoluenes derivable therefrom. Ortho- and para-bromotoluenesulphonic acids." By A. K. Miller, Ph.D.

It is shown that parabromotoluene affords *two* dibromotoluenes, viz., orthoparadibromo- and metaparadibromo-toluene, the latter being the major product; orthobromotoluene yielding orthoparadibromotoluene as minor product, together with the orthometa-derivative containing the bromine atoms relatively in the para-position. Parabromotoluene also yields some 1 : 2 : 4 : 5-tribromotoluene (Me = 1), which appears to be derived from the 1 : 2 : 4-di-derivative.

60. "Note on the constitution of Nevile and Winther's orthotoluidinesulphonic acid, and on the acids formed by sulphonating orthochloro- and bromo-toluene." By W. P. Wynne, D.Sc.

A comparison of the chloro- and bromo-acids obtained by Sandmeyer's method from Nevile and Winther's orthotoluidinemetasulphonic acid with those formed from orthochloro- and orthobromotoluene by sulphonation has established their identity. Nevile and Winther gave reasons for assigning to their acid the constitution [$Me : NH_2 : SO_3H = 1 : 2 : 5$], but further evidence seemed desirable in view of the nature of their proof. The metabromorthotoluidinemetasulphonic acid formed from Nevile and Winther's acid by careful bromination was converted by Sandmeyer's method into the corresponding dibromotoluenesulphonic acid, and the sulphonic radicle was eliminated from the acid by hydrolysis with phosphoric acid in a current of superheated steam; the resulting dibromotoluene was identified as the 1 : 2 : 3-derivative, since it melted at 30—31°, and its nitro-derivative at 59°. It hence follows that the bromotoluidinesulphonic acid has the constitution [$Me : NH_2 : Br : SO_3H = 1 : 2 : 3 : 5$], and Nevile and Winther's acid that assigned to it by them.

61. "The action of iodine on a mixture of sulphite and thiosulphate." By Arthur Colefax, M.A., Ph.D.

This paper has reference to Spring's contention, advanced in his recent note in the Proceedings (1892, 91), that although it is true, as the author had asserted, that no trithionate is formed by the action of iodine on a mixture of sodium sulphite and thiosulphate, trithionate is produced if potassium salts are used in place of sodium salts. It is shown that trithionate is not produced by the action of iodine either on the potassium or sodium salts, and that the formation of trithionate is due to the occurrence of a secondary interaction of tetrathionate and sulphite, which takes place when the iodine acts slowly, as it does, especially when used in the solid state. It is also shown that when iodine acts on a solution containing both sulphite and thiosulphate of potassium or sodium, present in molecular proportions, it oxidises the sulphite only slightly more quickly than it converts the thiosulphate into tetrathionate.

62. "The methylic salts of camphoric acid." By James Walker, Ph.D., D.Sc.

The author has prepared the dimethyl and the two methyl hydrogen salts of camphoric acid, and finds their properties to be in the main the same as those of the compounds described by Brühl and Braunschweig and by Haller. Orthomethylic sodic camphorate may be obtained by adding 1 mol. prop. of powdered camphoric anhydride to a cold solution of 1 at. prop. of sodium (1 mol. prop. sodium methoxide) in methyl alcohol; the corresponding hydrogen salt may be prepared by acidifying the sodium salt. If 1 mol. prop. of methyl iodide be added in addition, and the mixture be heated for 24 hours at 100°, dimethylic camphorate is formed. The author succeeded in obtaining the allomethylic hydrogen camphorate in a measurable form by crystallisation from metaxylene. The "dissociation" constant of the ortho-compound is 0·00108, of the allo-compound 0·000975, which are nearly equal and not far removed from half of that of camphoric acid, viz., 0·00225. These values correspond with the assumption that camphoric acid is a dicarboxylic acid, and are at variance with the formula proposed by Friedel.

November 17, 1892. Sir Henry Roscoe, M.P., F.R.S., Vice-President, in the Chair.

On taking the Chair, Sir HENRY ROSCOE congratulated the Fellows on the very great improvement effected in the Society's rooms, especially in the meeting room, during the recess.

The Treasurer, Professor THORPE, agreed with the Chairman in thinking that the Fellows present had good reason to congratulate themselves on the changed conditions under which they met. The meeting room had undergone, as they saw, what was practically complete reconstruction, the position of the table and of the seats having been altered, with the result that not only had a very considerable air-space been gained, which would tend to the better ventilation of the room, but also additional accommodation, both in actual seating space and in the means of entrance and exit, had been secured. Provision had been made for a larger supply of fresh air and for the removal of that which passed into the rooms. Moreover, it would be noticed that the electric light had been substituted for gas as an illuminant throughout the building; this, it was hoped, would promote the comfort of Fellows attending the meetings, not only in its effect on the nature of the air within the rooms, on the cleanliness of the apartments, and on the preservation of their decorative character, but also by affording greater facilities for the exhibition of specimens, diagrams and lantern projections. It would be understood that the structural and other alterations required by these changes necessarily occupied a considerable time, and, although every effort had been made to complete the changes within the recess, it had been considered desirable to postpone the date of the opening meeting to a week or so later than the usual time, in order to secure everything being in proper working order when the Society met. The structural alterations had been planned and their execution superintended by Mr. Martin L. Saunders, to whom the thanks of the Society were due for the care and assiduity with which he had charged the duty he undertook. These alterations had been made by Messrs. Colls and Son, who had also carried out the redecoration of the whole of the apartments to the entire satisfaction of the Committee. The installation of the electric lighting was planned by Professor Ayrton, to whom the Society was under a very special obligation for the great amount of time, thought and energy he had expended on the work. The business of wiring the building and of affixing the fittings was entrusted to Messrs. Spagnoletti and Crookes, with the result that all present were able to enjoy. The fittings, that is, brackets and pendants, were supplied by Messrs. Faraday and Sons, and do credit to the reputation of that firm for artistic work. Experience could alone show how these various alterations would work in practice, but enough had been seen already to indicate that they were undoubtedly great improvements, and would conduce to the health and comfort of the Fellows.

On the motion of the Chairman, seconded by the Treasurer, it was resolved, that the best thanks of the Fellows be tendered to Mr. Martin L. Saunders and Professor Ayrton for their valuable services.

Certificates were read for the first time in favour of Messrs Robert Samuel Adcock, Rio Tinto Mines, Huelva, Spain; William Smellie Anderson, Marine Station, Granton; David Avery, Queen's College, Melbourne University, Australia; Arthur John Bensusan, 13, Lansdown Road, Kensington Park, W., and Darling Point, Sydney; Horace Vincent Buttfield, 16, Thistlewaite Road, Clapton, N.E.; Frederick Walter Carlton, Marlow House, Swindon; Ernest Victor Clark, 5, Tisbury Road, West Brighton; Arthur James Cooper, The Schoolhouse, Bromyard, Herefordshire; Andrew William Craig, 77, Peel Street, North Melbourne; Joseph R. Denison, 1, Park View Terrace, Manningham, Bradford; Thomas Duxbury, Richmond Terrace, Darwen; Martin Onslow Forster, 32, Binfield Road, Clapham Road, S.W.; William French, 74, Walmersley Road, Bury, Lancashire; Walter Goodall, Alma House, Pudsey, near Leeds; John Goodfellow, F.R.M.S., 2, Rutland Terrace, High Road, Leyton, Essex; Thomas Gray, 16, Craigmore Terrace, Dowanhill, Glasgow; William Thomas Gronow, Port Pirie Smelting Works, Port Pirie, South Australia; Walter S. Haines, Chicago, U.S.A.; James G. Hardy, 1, Keir Terrace, Pollokshields, Glasgow; Samuel C. Hooker, Philadelphia, U.S.A.; John Horsfall, 88, Scar Terrace, Bacup, Lancashire; Edgar Edward C. Horwill, 104, Ferndale Road, Clapham, S.W.; W. H. Ince, Ph.D., 12, Cowley Street, Dean's Yard, Westminster; John F. V. Isaac, 18, Montserrat Road, Putney, S.W.; John Jackson, Rhymney; Samuel Jackson, Nether Thong, Huddersfield; William George Johnston, 4, Hilgrove Road, Finchley Road, Hampstead, N.W.; K. K. Kacker, Delhi, India; Thomas Torrens Knowles, School House, Lancaster; G. Krause, Cöthen, Anhalt, Germany; Thornton Charles Lamb, Polygon, Ardwick, Manchester; William Howard Lloyd, 5, Belmont Villas, New Walk, Leicester; Arnold G. Maddox, 15, Fleetwood Street, Clissold Park, N.; Colin Francis Moorwood, 260, Barnsley Road, Sheffield; J. B. Nickolls, 8, College Terrace, Grange, Guernsey; Hugh Ramage, Royal College of Science, Dublin; James Wyllie Rodger, 76, Anerley Park, S.E.; Norman Scott Rudolf, Sewan Sarun, Bengal, India; Satyaprasad Sarbadhicary, 53, Wellington Street, Calcutta; Augustus Schloesser, Ph.D., M.Sc., 7, Victoria Crescent, Busby, near Glasgow; William

James Sell, 1, Bene't Place, Cambridge; George Arthur Shaw, 112, Bramhall Lane, Stockport; Reginald des Foyes Shepherd, 6, Coltman Street, Hull; Charles Spackman, Sileby, Loughborough; Ernst Speidel, B.S., 17, Quincy Street, Chicago, Illinois; A. H. Turton Ashley, Carlisle Road, Edgbaston; Frederick William Westaway, 1, Aytoun Road, Stockwell, S.W.; John Lowe Whiteside, 51, Canon Street, Bolton; Frederick Henry Wigham, 25, Pinderfield Road, Wakefield; William Williams, Smithfield Street, Dolgelly, N. Wales; N. T. M. Wilsmore, Altona, Orrony Road, Elsternwick, Melbourne.

The Chairman announced that the following address had been forwarded to the sister society in Berlin:—

Address to the Deutsche chemische Gesellschaft.

The Chemical Society of London desires to offer its warmest congratulations to the Deutsche chemische Gesellschaft on the occasion of the celebration of its Twenty-fifth Anniversary, while, at the same time, it joins with the sister Society in deploring most deeply the recent irreparable loss of one who was long so intimately associated with both bodies, who exercised so important an influence on their development, and who took so large a share in the guidance of the affairs, first of the one and then of the other.

The Chemical Society of London is proud to think that it may properly regard the German Society as its direct lineal descendant through Hofmann. No offspring could possibly have done greater credit to its parent; indeed, the rapidity of growth and youthful vigour of the offshoot is beyond all precedent. A true mirror of the progress of chemical science, the stately series of volumes issued by the Society during the first quarter-century of its existence, will ever serve as the priceless historical record of the marvellous advance of chemistry during the period; and that advance would appear to be in no small degree due to the incitement afforded to experimental inquiry by the regular and frequent issue of the now far-famed *Berichte*.

But probably it will in the future come to be regarded as the greatest service of the Deutsche chemische Gesellschaft that it has done so much to render possible the ultimate denationalisation of chemical science. Chemists of all nations record their results in the pages of its publication, which has become a meeting ground where international jealousies disappear and the spirit of utmost toleration prevails. No one more clearly recognised the greatness of such a service than Hofmann. In 1863, when President of the Chemical Society of London, speaking at the Twenty-second Anniversary

Meeting of the delivery of lectures to the Society by distinguished foreign chemists, he said: "The Chemical Society has loudly proclaimed the cosmopolitan character of science, and that henceforth it will look upon the several nations engaged in scientific pursuits as upon so many federal members of a great Republic united by the love of science, and pledged by contributions to a common treasury, as it were, to uphold its cause and raise its dignity." The cosmopolitan influence of the great moving spirit of its councils during the first 25 years of the existence of the Deutsche chemische Gesellschaft will ever be regarded as a priceless service rendered to chemical science by Hofmann.

The following resolution was passed at the meeting of the Council in the afternoon:—

> "The Council learns with deep regret that, through the death of Dr. Longstaff, on the 23rd September last, the Society has lost its senior Fellow and one of its founders.
>
> "The deep interest which Dr. Longstaff took in the Society and in the promotion of the interests of chemical science having been evinced by the munificent gift which secured the establishment of the Research Fund, his name will ever remain associated with the history of the Society and will be retained fresh in the memory of the Fellows through the triennial award, to those who have distinguished themselves in chemical research, of the Medal bearing his name."

The following papers were read:—

63. "Fluosulphonic acid." By T. E. Thorpe, F.R.S., and Walter Kirman.

The authors have prepared this compound by distilling a slight excess of hydrogen fluoride into a weighed platinum flask containing a known amount of sulphuric anhydride, both the condensing tube and the receiver being surrounded with a mixture of ice and calcium chloride; the excess of hydrogen fluoride was subsequently removed by passing a current of dry carbon dioxide through the liquid product at a temperature between 25° and 35°. The interaction is attended with the development of much heat.

Fluosulphonic acid, SO_3HF, is a thin, colourless liquid boiling with slight decomposition (apparently into SO_2F_2 and SO_4H_2) at 162·6°, which, it is noteworthy, is a higher temperature than that at which chlorosulphonic acid boils (155·3°). It has but little action on the dry skin, feeling greasy to the touch, and being without the intense blistering action of hydrogen fluoride.

DISCUSSION.

Professor RAMSAY expressed the opinion that the name fluorosulphonic acid was preferable to fluosulphonic acid.

Mr. PAGE and also Sir HENRY ROSCOE asked whether the isolation of fluorine had been confirmed by any independent observer since the announcement of Moissan's discovery.

Dr. ARMSTRONG said the fact that fluosulphonic acid had a higher boiling point than chlorosulphonic was of special interest, as in the case of corresponding "atomic" compounds the fluorine compound, as a rule, had a lower boiling point than the chlorine compound; he thought that on the whole the evidence favoured the view that chlorosulphonic acid was a so-called molecular compound, and, perhaps, an explanation was to be found in this direction. He suggested also that probably the fluor- and chlor-acids would be found to yield the "pyrofluoride" and the pyrochloride, and not the sulphuryl compounds on distillation.

Professor THORPE, in reply, said that he had no special views with regard to the use of the syllable fluor- instead of fluo-. He had spent considerable time in attempting to repeat Moissan's work, without obtaining definite results; but possibly he had not had the good fortune to hit on the precise experimental conditions requisite for succes. He had, however, given Moissan a long account of his trials without obtaining any specific information from him in reply.

64. "Note on the interaction of iodine and potassium chlorate." By T. E. Thorpe, F.R.S., and George H. Perry.

The interaction is usually represented by the equation $3KClO_3 + I_2 = KClO_4 + KCl + KIO_3 + ICl + O_2$; the authors find, however, that it primarily and in the main involves a simple interchange of iodine and chlorine: $2KClO_3 + I_2 = 2KIO_3 + Cl_2$. When care is taken in heating the mixture, it is possible to convert practically the whole of the iodine present into potassium iodate, the equivalent amount of gaseous chlorine being liberated.

65. "The magnetic rotation of sulphuric and nitric acids, and of their aqueous solutions; also of solutions of sodium sulphate and lithium nitrate." By W. H. Perkin, Ph.D., F.R.S.

The author has previously shown that, although the molecular rotations of the fatty acids and their ammonium salts are not appreciably influenced by the presence of water, yet that of sulphuric acid is to a considerable extent, the rotation rapidly falling for small dilutions, but diminishing as the amount of water is increased; in these experiments the examination was only extended to a mixture corresponding to $H_2SO_4 + 30H_2$. Nitric acid was also found to behave in a similar manner.

On account of remarks by Professor Ostwald on these results, and the interest which is taken in the subject of solutions, a more extended series of observations has been undertaken. The results are given in the paper in a tabular form, and are also represented graphically. In the case of sulphuric acid and sodium sulphate, it is shown that there is no apparent connection between the value for the rotation and extent to which dissociation is supposed to take place down to solutions containing about 9 per cent. of acid or 12 per cent. of sodium sulphate. The same conclusion was come to from the examination of solutions of these substances at temperatures of about 90°, when the rotation increased instead of diminishing, as it should have done, according to the dissociation hypothesis. The results, however, are not inconsistent with the assumption that combination takes place with the formation of $(HO)_4SO$.

The results obtained with nitric acid give a different kind of curve to that afforded by sulphuric acid, viz., one consisting of a practically straight line down to solutions containing about 33 per cent. of HNO_3, after which it appears to curve somewhat downwards; and, although it does not deviate so much as sulphuric acid from that representing the dissociation, yet it does not correspond at all closely with it. It is considered that these results may indicate the formation of a compound resulting from the union of the acid with water, *e.g.*, $(HO)_3NO$.

Lithium nitrate resembles nitric acid in its behaviour. The rotations of the haloid hydrides in aqueous solution are also referred to, showing that as those of the concentrated solutions at first change very rapidly with small dilutions, but more slowly with large dilutions, at last becoming nearly stationary, they are not in agreement with their dissociation, which increases with dilution.

66. "Note on the refractive indices and magnetic rotations of sulphuric acid solutions." By S. U. Pickering.

The values for the refractive indices of these solutions obtained by van der Willingen when plotted out and examined by a flexible lath, show the existence of a well-marked "break" as well as a maximum at 84·5 per cent. (the monohydrate), another "break" at 57·7 per cent. (the tetrahydrate), and another at 24—30 per cent. The first two of these agree with the breaks shown by the magnetic rotations, and all three of them agree with breaks found in the examination of other properties. The experimental points available were not sufficiently numerous to indicate more than the most prominent "breaks," and it was found that the densities when treated so as to lead to the indications of the most prominent "breaks" only, indicated these same three. For this purpose the molecular volumes were calculated from the densities of solutions of the same strength as those used by Dr. Perkin, and when plotted out they showed "breaks" at 83·5, 60 and about 30 per cent. When the same number of values, but for solutions of different strengths, were taken, the same "breaks" were still indicated.

DISCUSSION.

Professor RAMSAY drew attention to a work by van der Waals, on the *Continuity* of the liquid and gaseous states, the fundamental equation underlying all the calculations in which is—

$$p = \frac{RT}{(v - b)} - \frac{a}{v^2}.$$

This expression, graphically interpreted, gives a curve of double flexure, with very abrupt changes of curvatures, provided numbers be appropriately chosen. (The curve was drawn on the black board.) He entirely dissented from Mr. Pickering's conclusions as regards "breaks," and denied the existence of anything but continuous transitions from one state to another; and he maintained that it was no more sensible to attempt to detect "breaks" with a bent lath than to assume that all curves were parabolas or circles.

Dr. WALKER drew attention to the circumstance that in calculating the amount of electrolytic dissociation from the electrical conductivity of mixtures of sulphuric acid and water Dr. Perkin had neglected to take account of one of the factors which determine the conductivity, namely the speed of the ions, which is intimately connected with the viscosity of the solutions. His "dissociation" curves, therefore, did not represent at all the actual degree of dissociation in the strong solutions studied by him, for in them the viscosity is comparatively great. The same objection applied to the temperature experiments. The great increase of conductivity caused by elevation of temperature is due almost exclusively to the increased speed of the ions, and not to any change in the dissociation. In his opinion, therefore, the conclusions drawn by Dr. Perkin as to the want of concordance between his results and the theory of electrolytic dissociation were from this cause invalid.

Mr. PICKERING, in reply to Professor Ramsay, said that, as he had long ago pointed out, there were, of course, many classes of curves which were not amenable to treatment with a flexible lath; the fact that Professor Ramsay was able to instance one of these neither proved nor disproved anything.

67. "The hydrate theory of solutions. Some compounds of the alkylamines with water." By S. U. Pickering.

In making a series of determinations of the freezing points of solutions of these amines it was found that most of them formed one or more definite crystalline hydrates. Sixteen amines were examined, of which two were entirely and two very sparingly soluble, and 24 hydrates in all were isolated. Hydrates with the same number of water molecules occur in many different cases, but no connection could be traced between the degree of hydration and the nature of the amine. Indications of hydrates were also obtained by "breaks" in the curves representing the freezing points, and in every instance but one a hydrate of the composition thus indicated in the case of one amine was actually isolated in the crystalline condition in the case of some other amine. The lowest hydrate isolated (in four cases) contained $\frac{1}{2}H_2O$, and the highest $11H_2O$. The freezing points of the hydrates ranged from +5° to −71°. In the case of the amines themselves, as well as of such hydrates as contain the same number of water molecules, the freezing points seem to fall as the number of carbon atoms present in the alkyl radicle increase, and to rise as the number of radicles in the amine increases. The following is a list of analysed hydrates isolated as crystals :—

$EtNH_2,5H_2O$
$PrNH_2,5H_2O$
$Et_2NH,5H_2O$
$Pr_2NH,5H_2O$
Me_2NH,H_2O
$Et_3N,2H_2O$
$Me_3N.3H_2O$

$EtNH_2,5\cdot5H_2O$
BNH_2(iso-),$7H_2O$
$Me_2NH,7H_2O$
$PrNH_2$(iso-),$8H_2O$
$PrNH_2,8H_2O$
$Et_2NH,8H_2O$
$Me_3N,11H_2O$

Discussion.

Professor Thorpe, after referring to the fact that the late Professor Guthrie had investigated the relationship of certain of the alkylamines to water as far back as 1884 (*Phil. Mag.; Phys. Soc. Proceedings*, 1884, 169), said that among other things Guthrie had pointed out that while a mixture of triethylamine and water containing from 15 to 50 per cent. of the alkylamine was clear and transparent at ordinary temperature, on warming it became suddenly turbid, owing, apparently, to the triethylamine being thrown out of solution. On cooling the liquid it again became clear, but could again be rendered turbid on warming. The temperature at which this change occurs is remarkable constant, viz., about 18·4°. In this behaviour a solution of triethylamine in water resembles an aqueous solution of ammonia. It occurred to the speaker to try whether the effect of pressure on the solution would be to increase the apparent solubility of the alkylamine in water by observing whether the turbidity would disappear under pressure, the temperature being maintained above 18°·4. Experiments showed that this was the case. By enclosing a quantity of the solution in a Cailletet tube to which pressure could be applied in the ordinary way by the Ducretet pump, it was found that on rendering the liquid turbid by surrounding the tube with tepid water the turbidity almost instantly disappeared when the pressure was increased a few atmospheres, and as quickly reappeared on releasing the pressure. Professor Thorpe proceeded to demonstrate this phenomenon with the aid of the electric light by throwing an image of the tube on the screen. On gently warming the tube the solution became so turbid as to practically stop the passage of the light. On applying pressure, the solution was seen to clarify, but on releasing the pressure it again became milky, and, in fact, nearly opaque.

68. "The atomic weight of boron." By Emily Aston, B.Sc. (Lond.), and William Ramsay, Ph.D., F.R.S.

An account is given of the redetermination of the atomic weight of boron by two methods—by the determination of the water of crystallisation in borax, and by the conversion of anhydrous sodium borate into sodium chloride by distillation of the borax with chlorhydric acid and methyl alcohol, and weighing the resulting sodium chloride.

The aggregate of seven experiments in which 42 grams of borax were deprived of water gave as atomic weight 10·921, with a probable error of 0·01.

Two series of experiments were made in which borax was converted into sodium chloride. The first series, in which over 20 grams were employed, gave as atomic weight 10·942; the second series, in which more than 23 grams were converted, gave as atomic weight 10·966. The result of the second series is regarded as more probably correct.

The authors discuss the discrepancy between their results and Abrahall's (*C. S. Trans.*, 1892, 650) and give reasons why they regard the value deduced by this observer (10·825) as too low; they think that his boron bromide may have been contaminated with hydrogen bromide present as $BBr_3 \cdot HBr$.

69. "Methoxyamido- 1 : 3-dimethylbenzene and some of its derivatives." By W. R. Hodgkinson and Leonhard Limpach.

Having devised a method of separating 1 : 2 : 4-metaxylidine from paraxylidine, &c., with which it is mixed in commercial xylidine, the authors have had the opportunity of preparing 1 : 2 : 4-metaxylenol in large quantity. An almost theoretical yield of this phenol was obtained by diazotising a solution containing only 5 per cent. of the xylidine sulphate and then steam distilling; the product did not solidify even at −20°; but a considerable quantity was caused to crystallise by adding solid obtained by cooling a small portion by means of carbon dioxide and ether. The presence of a trace of water was found to prevent crystallisation. On nitration, metaxylenol yields almost the theoretical amount of a nitroxylenol in which the NO_2 group is contiguous to the hydroxyl. The authors have prepared the corresponding amido- and hydroxy-xylenols and their methylated derivatives (dimethylanisoils); they also describe a quinaldine derivative, formed by condensation from the methoxyamidoxylene and ethylic acetoacetate.

ADDITIONS TO THE LIBRARY.

I. *Donations.*

A collection of Pamphlets on Chemical and other subjects in 70 vols. From Sir H. E. Roscoe, F.R.S.

The Threshold of Science, a variety of simple and amusing experiments illustrating some of the chief physical and chemical properties of surrounding objects, and the effects upon them of light and heat, by C. R. Alder Wright. London, 1892. From the Publishers.

A Systematic Course of Qualitative Chemical Analysis of Inorganic Substances, by C. F. Juritz. Capetown and Johannesburg, 1890. From the Author.

Transactions of the Sanitary Institute, Vol. XII, 1891. London, 1892. From the Institute.

Agricultural Chemistry, by A. Sibson: Revised by the Author and A. E. Sibson. London 1892. From the Authors.

On the History and Growing Utilisations of Tussur Silk, by T. Wardle. London 1891. From the Author.

Royal College of Physicians, Edinburgh: Reports from the Laboratory. Vol. IV. Edinburgh and London 1892. From the Council of the College.

On the Chemistry and Therapeutics of Uric Acid Gravel and Gout, by W. Roberts. London 1892. From the Author.

Matriculation Chemistry: Chemistry of the Non-Metallic Elements and their Compounds, by T. Orme. London 1892. From the Author.

The Year Book of the Imperial Institute of the United Kingdom, the Colonies, and India. First Issue. 1892. London 1892. From the Institute.

Commercial Organic Analysis, by A. H. Allen. 2nd Edition. Vol. III. Part II. London 1892. From the Author.

Six Lectures on the Investigations at Rothamsted Experimental Station, delivered under the Provisions of the Lawes Agricultural Trust, by R. Warington. Washington 1892. From the Author.

Chemical Theory for Beginners, by L. Dobbin and J. Walker. London 1892. From the Authors.

A General System of Chemical Knowledge and its Application to the Phenomena of Nature and Art, by A. F. Fourcroy. Translated by W. Nicholson. Eleven volumes. London 1804. From G. B. Buckton, Esq., F.R.S.

II. *By Purchase.*

Gärungstechnisches Jahrbuch, herausgegeben von A. Schrohe. Erster Jahrgang 1891. Berlin 1892.

Leçons de Chimie à l'usage des élèves de mathématiques spéciales, par H. Gauthier et G. Charpy. Paris 1892.

Ueber die Theorie der Lösungen, von A. Horstmann. Heidelberg 1892. (Pamphlet.)

Der Indigo vom practischen und theoretischen Standpunkt, dargestellt von G. v. Georgievics. Leipzig u. Wien 1892.

Handbuch der Anorganischen Chemie. herausgegeben von O. Dammer. Drei Bände: Band I. Stuttgart 1892.

Stereochemie, nach J. H. Van't Hoff's Dix années dans l'histoire d'une théorie; unter Mitwirkung des verfassers neu bearbeitet von W. Meyerhoffer. Leipzig und Wien 1892.

Traité de Chemie agricole, par P. P. Dehérain. Paris 1892.

Extra Meeting, December 13th.

An extra meeting of the Society will be held on Tuesday, December 13th, at 8 P.M., the anniversary of the death of Stas. A paper, specially prepared for the occasion by Professor J. W. Mallett, F.R.S., entitled "*Jean Servais Stas, and the measurement of the relative masses of the atoms of the chemical elements*," will be read and discussed.

At the next meeting, on December 1st, the following papers will be read:—

"Isolation of two predicted hydrates of nitric acid." By S. U. Pickering.

"Notes on anhydrous oxalic acid." By W. W. Fisher.

"The formation of orcinol and other condensation products from dehydracetic acid." By J. Norman Collie.

"Observations on the origin of colour and of fluorescence." By W. N. Hartley.

"The origin of colour. (V.) Azobenzene." By Henry E. Armstrong.

"The reduction products of $\alpha\alpha'$-dimethyl-$\alpha\alpha'$-diacetylpentane. By F. S. Kipping.

"The products of the action of sulphuric acid on camphor." By H. E. Armstrong and F. S. Kipping.

"Methods of showing the spectra of easily volatile metals and their salts and of separating their spectra from those of the alkaline earths." By W. N. Hartley.

CERTIFICATES OF CANDIDATES FOR ELECTION AT THE NEXT BALLOT.

N.B.—The names of those who sign from "General Knowledge" are printed in *italics.*

The following Candidates will be balloted for on December 15th, 1892:—

Adcock, Samuel Robert,

Rio Tinto Mines, Huelva, Spain.

Analytical Chemist. I have been 4 years in the Laboratory of the Rio Tinto Company, Spain. 1 year 8 months Assistant, and 2 years 4 months Chief Assistant, Chemist. Science and Art Certificates. Honours 1st Practical Inorganic Chemistry, Honours 2nd Practical and Theoretical Metallurgy, &c. Member of the Mineralogical Society.

Frank Johnson.
William H. Martin.
W. H. Cannon.
P. Coulson Bunn.
E. Godwin Clayton.
Matthew Cannon.
J. Parry Laws.
William Newton.

Anderson, William Smellie,

Marine Station, Granton.

Analytical Chemist. Studied Theoretical, Analytical, and Agricultural Chemistry under Dr. Stevenson Macadam and Mr. Ivison Macadam; Organic Chemistry under Professor Crum Brown; Agriculture under Professor Wallace. Have been Chemist at Granton Marine Station for last 3½ years, under Dr. John Murray, of the "Challenger" Commission, and Mr. Irvine, F.C.S.

Robert Irvine. Stevenson Macadam. W. Ivison Macadam.
George Young. G. G. Henderson.

Avery, David,

Queen's College, Melbourne University.

Student. Bachelor of Science, Melbourne University. Kernot and Wysilaskie Scholar in Chemistry, and Final Honour Scholar in Chemistry, Melbourne University. Scholar of Queen's College.

Orme Masson. J. B. Kirkland. C. R. Blackett.
George Foord. *Robert Barton.* *Francis R. Power.*

Bensusan, Arthur John,

13, Lansdown Road, Kensington Park, W., and Darling Point,
Sydney, N.S.W.

Associate of the Royal School of Mines, South Kensington. Metallurgist. Was placed second in the First Class Division in the Final Examination in Metallurgy at the Royal College of Science. Has studied Chemistry at the Royal College of Science, and under Professor Dixon, Sydney, N.S.W.

T. E. Thorpe. W. C. Roberts-Austen.
Edwin J. Ball. Henry C. Jenkins.
Bennett H. Brough. Chapman Jones.

Buttfield. Horace Vincent,

16, Thistlewaite Road, Clapton, N.E.

Overseer and Analyst at Messrs. Vincent Brooks, Day, and Son, Lithographers. Member of the Society of Chemical Industry; 3 years a Student of Chemistry and Physics in the City of London College; Holder of 10 Certificates and Prizes awarded by the Science and Art Department in Inorganic Chemistry, Theoretical and Practical Organic Chemistry, Theoretical and Practical Experimental Physics, &c.

J. Howard. Isaac S. Scarf. James Scorgie.
A. E. Carey. *Vivian B. Lewes.* *F. Woodland Toms.*

Carlton, Frederick Walter,

Marlow House, Swindon,

Student (Chemical and Metallurgical). Studied Chemistry at the Edinburgh High School and obtained 1st Class Certificates. Engaged in practical work at own private Laboratory.

H. Joshua Phillips. F. M. Mercer. J. Jas. Morgan.
C. A. Serre. *Bertram Blount.*

Clark, Ernest Victor,

5, Tisbury Road, West Brighton.

Metallurgical Chemist. Associate of Royal College of Science (Chemistry, 1st Class). Associate of Royal School of Mines (Metallurgy).

W. C. Roberts-Austen. T. E. Thorpe. A. E. Tutton.
Chapman Jones. Edwin J. Ball.

Cooper, Arthur James,

The School House, Bromyard, Herefordshire.

Head Master of Bromyard School. B.Sc. (Lond.), First in the First Class in Honours in Chemistry. Senior Prize for General and

Theoretical Chemistry, Mason College, Birmingham. Senior Prize for Practical Chemistry, Mason College, Birmingham. Head Master of Bromyard Grammar School and Lecturer on Chemistry to the Herefordshire County Council.

William A. Tilden. W. W. J. Nicol. Thomas Turner.
Sidney Williamson. *Henry E. Armstrong.*

Cooper, Lionel,

173, Marylebone Road, London, N.W.

Teacher of Chemistry and Physics. For four years engaged in Chemical Research, and now Partner and Teacher of Chemistry and Physics in the Central School of Chemistry, 173, Marylebone Road, N.W.

A. W. Oxford. Lewis Ough. John Woodland.
Richard A. Hoyle. *C. R. Alder Wright.*

Craig, Andrew William,

77, Peel Street, North Melbourne.

Master of Arts, Melbourne University. Junior Demonstrator in Chemistry, Melbourne University. Lecturer in Chemistry, Melbourne University Extension Scheme.

Orme Masson. J. B. Kirkland. C. R. Blackett.
George Foord. *Robert Barton.* *Francis R. Power.*

Denison, Joseph R.,

1, Park View Terrace, Manningham, Bradford.

Analyst and Dyer's Chemist. Student three years at the Bradford Technical College, in the Chemistry and Dyeing Department. First Class Certificates in Theoretical and Practical Inorganic Chemistry. First Prize in Honours, Wool Dyeing, in 1889, City and Guilds Examination. For short time Demonstrator in Dyeing and Chemistry Department, Bradford Technical College. Now assistant to Thorp Whitaker, F.C.S., in the Chemical Department at Bowling Dye Works. Engaged in the manufacture of sulphuric acid, soap, indigo products, iron liquor, tin solutions and crystals, aluminium acetate, Glauber's salts, &c., and dyewood and tannin extracts.

Thorp Whitaker. Walter Leach. G. W. Slatter.
C. Rawson. F. W. Richardson.

Duxbury, Thomas,

Richmond Terrace, Darwen.

Engineer and Manager, Corporation Gas Works, Darwen, Lancashire. Have been Engineer and Manager of these Gas and Water Works for 15 years, and previous to this occupied similar position under the

Accrington Gas and Water Works Company. Many years ago I taught a private evening chemical class. Attended evening chemical classes at the Owens College, Manchester, for two sessions. Latterly have paid particular attention to Cooper's coal lining process and Bunsen process of gas making, sulphate making, tar distilling, &c. Am also Chemical Adviser to a Paper Mill Company here. Am Member of the Manchester Chemical Club, &c.

William Foster. Percy F. Frankland. B. E. R. Newlands.
W. J. Dibdin. *R. Grimwood.* *J. A. Formoy.*

Forster, Martin Onslow,
32, Binfield Road, Clapham Road, London, S.W.

Research Assistant to Professor Dr. Tilden, Mason College, Birmingham. In conjunction with Professor Meldola, I contributed "Researches on the Triazines" (*Chem. Soc. Trans.*, 1891). I have been for three years a Student at Finsbury Technical College, and then studied for one year at Würzburg, of which University I am a Ph.D. I am working at present under Professor Tilden, of Birmingham.

R. Meldola. Henry E. Armstrong. William A. Tilden.
W. W. J. Nicol. Sidney Williamson.

French, William,
74, Walmersley Road, Bury, Lancashire.

1st Class Nat. Science Tripos, 1890, Cambridge. A.I.C. by examination, 1889. Many years Assistant to Professor Liveing, F.R.S., at the University Chemical Laboratory, Cambridge. Note on "Estimation of Gold, Tin, and Cadmium" (*Chem. News*, March 18, 1892). Investigations on the separation of Platinum Metals with Professor Liveing (unpublished).

G. D. Liveing. W. C. Roberts-Austen. H. J. H. Fenton.
Alexander Scott. James Dewar. S. Ruhemann.
M. M. Pattison Muir.

Goodall, Walter,
Alma House, Pudsey, near Leeds.

Analyst. Associate of the Institute of Chemistry. Student for three years at Yorkshire College, Leeds.

Arthur Smithells. Herbert Ingle. Charles H. Bothamley.
C. Rawson. *Frederic Wm. Richardson.*

Goodfellow, John, F.R.M.S.,
2, Rutland Terrace, High Road, Leyton, Essex.

Lecturer on Physiological Chemistry at the Bow and Bromley Institute, and Analytical Chemist. 1. Late Senior Demonstrator at the

Chemical Laboratory, Charterhouse. 2. Lecturer on Physiological Chemistry and Food Analysis at the Bow and Bromley Institute, London. 3. Author of *The Dietetic Value of Bread* (Macmillan), containing many original Researches on the Chemistry of Bread. Also co-author of *Physiological Chemistry* (Gill and Son).

H. E. Roscoe. Hugh Gordon. David Howard.
David Salomons. *Edwd. Rider Cook.*

Gray, Thomas,

16, Craigmore Terrace, Dowanhill, Glasgow.

Assistant to Professor of Chemistry, Glasgow and West of Scotland Technical College. Bachelor of Science, University of London. I have conducted courses of Lectures in Organic and Inorganic Chemistry, and am at present Assistant to Professor Henderson, M.A., D.Sc., in the above College.

G. G. Henderson. Edmund J. Mills.
Chas. A. Fawsitt. Alex. Crum Brown.
John McArthur.

Gronow, William Thomas,

Port Pirie Smelting Works, Port Pirie, South Australia.

Metallurgist. Graduate of the Ballarat School of Mines in Chemistry, Metallurgy, Assaying, Mineralogy, &c.; Chemistry Scholar of Ormond College at University of Melbourne; Demonstrator of Chemistry, Metallurgy, and Assaying. and Lecturer in Elementary Science at the School of Mines, Ballarat; Analyst and Assayer to the Pinnacle Group Silver Mining Company, the Commodore Vanderbilt Gold and Silver Mining Company. and the Broken Hill Proprietary Company, Australia; Metallurgist to the Australian Smelting and Refining Company (Limited). and to the Broken Hil' Proprietary and Block 14 Companies at Port Pirie Smelting Works.

Gregory Board. Frank Mousley. Thomas J. Greenway.
George Foord. *Edward H. Rennie.*

Haines, Walter S.,

Chicago, U.S.A.

Professor of Chemistry in Rush Medical College, Chicago, U.S.A.; has been the Professor of Chemistry in Rush Medical College for the past 14 years; is the Consulting Chemist to the Health Department of the City of Chicago; is Toxicologist to the Presbyterian Hospital, Chicago; has contributed numerous articles on Medical Chemistry to Medical Journals, &c.

John A. Miller. Edw. Gudeman. Theodore S. Wormley.
C. F. Chandler. *Elwyn Waller.*

Hardy, James G.,

1, Keir Terrace, Pollokshields, Glasgow.

Assistant to Professor Sexton, Metallurgical Department, Anderson's College. For $3\frac{1}{2}$ years a Student under the late Professor Dittmar, and now Chief Assistant to Professor Sexton in teaching, and in private analytical work.

A. Humboldt Sexton. G. G. Henderson. R. R. Tatlock.
T. A. Cheetham. Chas. A. Fawsitt.

Hooker, Samuel C.,

Philadelphia, U.S.A.

Chemist to the Franklin Sugar Refining Company, 701, South Front Street. Ph.D. (Munich); Author of Papers on "Action of Aldehydes and Ammonia on Benzil" (with Professor Japp); "Retene" (*Liebig's Annalen*, with Professor Bamberger); "Lapachic Acid," and numerous other subjects.

F. R. Japp. Henry E. Armstrong.
W. P. Wynne. Chapman Jones.
T. E. Thorpe. *W. Ramsay.*

Horsfall, John,

88, Scar Terrace, Bacup, Lancashire.

Science Master. Studied Chemistry at the Royal College of Science, London; Chemistry and Mathematical Master at the Grammar School, Newchurch-in-Rossendale, Lancashire.

Jos. Hill Heywood. W. W. Haldane Gee.
William Jago. *J. Hart.*
W. P. Wynne. *Wm. Tate.*

Horwill, Edgar Edward C.,

104, Ferndale Road, Clapham, S.W.

Schoolmaster. (1) Lecturer in Theoretical and Practical Chemistry at St. John's Middle Class Schools, Kennington, S.E., to the London School Board, and Queen's Park Institute, Harrow Road, W.; (2) seven years' experience in laboratory work, &c., as Student and Lecturer; (3) the following South Kensington Science Certificates (*all First Classes*): (*a*, *b*) Inorganic Theoretical Advanced, 1885 and 1888, (*c*, *d*) Inorganic Practical Advanced, 1885 and 1888, (*e*) Organic Theoretical Advanced, 1886, (*f*) Organic Practical Advanced, 1886.

Alonzo John Rider. Wm. B. Hards.
F. W. De Velling. *George Collar.*
James Hall.

Ince, Walter Hollinshed, Ph.D. (Würzburg),

12, Cowley Street, Dean's Yard, Westminster.

Demonstrator of Chemistry at St. Thomas's Hospital, lately Demonstrator of Chemistry at University College, Liverpool. Studied for $3\frac{1}{2}$ years at the University of Würzburg, and then for $1\frac{1}{2}$ years at the Polytechnicum of Zurich. Author of the following contributions:—"On the formation of Phenyl-indoles by Isomeric Change" (*C. J. Proc.* and *Annalen*, **253**, 35); "Action of Amines on Diketopentamethylene" (*Ber.*, **23**, 1478, *C. J. Abstr.*); with Professor Dunstan, "Contributions to our Knowledge of the Aconite Alkaloïds" (*C. J. Trans.*, 1891, 271).

Wyndham R. Dunstan. J. Campbell Brown.
Charles A. Kohn. W. Collingwood Williams.
Thomas S. Dymond.

Isaac, John F. V.,

18, Montserrat Road, Putney, S.W.

Engaged in Chemical Research. Student at Owens College for a year, 1886—1887; four years, 1887—1891, at Oxford, Second Class Honours Chemistry, B.A.; engaged in research work in laboratory of Messrs. Cross and Bevan during the last six months.

W. W. Fisher. John Watts. V. H. Veley.
Chas. Fred. Cross. Edward Bevan. J. E. Marsh.

Jackson, John,

Rhymney.

Analytical Chemist. Seven years as Analytical Chemist under the Rhymney Iron Company, during which time have studied the manufacture of iron and steel, passing in Honours in Science and Art Department.

Fred. R. Stone. G. T. Evans. J. Jas. Morgan.
H. Joshua Phillips. *J. M. Collett.* *C. A. Serre.*
W. B. Roberts.

Jackson, Samuel,

Nether Thong, Huddersfield.

Analyst and Assistant in Dyehouse. 3 years Student at Royal College of Science, London; $1\frac{1}{2}$ years Student at Yorkshire College (Dyeing Dept.); Associate (in Chemistry) of the Royal College of Science, London; Associate of the Institute of Chemistry (Elected October, 1890); $1\frac{1}{2}$ years Analyst at Meltham Mills, Huddersfield.

T. E. Thorpe. J. J. Hummel. Arthur Smithells.
Herbert Ingle. *J. B. Cohen.*

Johnston, William George,

4, Hilgrove Road, Finchley Road, South Hampstead, N.W.

Analytical Chemist. Demonstrator in Chemistry, Anderson's College, Glasgow, 1878–80; during this time was engaged on research and analytical work in general, and in particular assisted the late Professor W. Dittmar, LL.D., F.R.S., &c., in his "Investigation on the Composition of Ocean Water," "*Challenger*" *Reports, Phys. and Chem.*, vol. **1**, Pt. I; for last five years private Assistant to Dr. Albert R. Leeds, Stevens Institute of Technology, Hoboken, N.J., United States, and co-operated with him in Investigations on Methods of Water and Food Analyses, which are embodied in the Journals and Transactions of the American Chemical Society, the Franklin Institute, &c.

W. S. Curphey.
R. T. Plimpton.
Alfred H. Allen.
R. R. Tatlock.
Watson Smith.
M. F. Roberts.

Kacker, Kunwar Kishor,

Delhi, India (London address, 3, Burton Crescent, W.C.).

Student of Chemistry. 1. Passed Matriculation Examination of Calcutta and Allahabad Universities. 2. Student at Lahore Medical College, 1887–89; Studies passed: Chemistry, Physics, Materia Medica, and Pharmacy. 3. Student at Grant Medical College, Bombay, 1889–91; same subjects as above, with Mechanics of Solids and Fluids. 4. Private Student of Chemistry in London since July, 1891. 5. As an Indian returning to India, I wish to retain a scientific connection with England, and intend diffusing chemical knowledge in India, where its widening influence is much needed.

Otto Hehner.
E. G. Clayton.
Alfred Hy. Allen.
Bernard Dyer.
John M. Thomson.
Robert H. Davies.

Knowles, Thomas Torrens,

School House, Lancaster.

Schoolmaster. M.A. (Cambridge), M.A. (Royal University, Ireland; Science and Mathematical Master, Lancaster Grammar School; experience in the Laboratories of Cambridge University and Queen's College, Belfast; Cambridge University Extension Lecturer in Chemistry, &c.

T. H. Easterfield.
G. S. Turpin.
A. Hutchinson.
H. J. H. Fenton.
Sydney Lupton.

Krause, G.,

Cöthen, Anhalt, Germany.

Redacteur of the *Chemiker Zeitung.*

Victor Meyer. E. Erlenmeyer. Otto N. Witt.
R. Meldola. *Henry E. Armstrong.*

Lamb, Thornton Charles,

Polygon, Ardwick, Manchester.

Research Student at Owens College. Four years Assistant Chemist in Tar Distillery. Three years Student in Chemical Laboratories, Owens College; Science Exhibitioner for 1892 (1851 Exhibition). Has published, with Dr. Bailey, "A Redetermination of the Atomic Weight of Palladium," *J. Chem. Soc.*, 1892.

Harold B. Dixon. W. H. Perkin, Junr. Arthur Harden.
Gilbert J. Fowler. G. H. Bailey.

Lloyd, William Howard,

5, Belmont Villas, New Walk, Leicester.

Wholesale Manufacturing Chemist. Educated at the Wyggeston Hospital School or Leicester Grammar School. For two years Head Assistant in the Manufacturing Laboratory of Messrs. Richardson and Co., of this town, and since then four years' experience in Manufacturing Pharmaceutical and Analytical Work; holder of the Assistant's Certificate of Apothecaries' Society and Associate of Pharmaceutical Society, and now of the firm of J. Howard Lloyd and Co., Manufacturing Chemists, Leicester.

Wm. Harkness. Samuel Francis Burford. John Hodgkin.
J. Bell. *H. J. Helm.* *C. Proctor.*
J. Woodward.

Maddox, Arnold G.,

15, Fleetwood Street, Clissold Park, London, N.

A.C.P., 1st Honours, &c. Head Master, holding nearly thirty diplomas, including Advanced Chemistry, Physics, Mathematics, &c. Science Lecturer (Chemistry, &c.), Highbury Institute, N., and just appointed as same to the Bucks County Council (Slough-Windsor centre). Science Writer (Agricultural Chemistry, Hygiene, &c.) to the *Teacher's Aid.* A-Section Editor of *Science, Art, and Technical Education.* Author of "Solutions to Chemistry Questions, May, 1892." Ten years' work as a Science Lecturer (Hygiene, Physiology, Chemistry, Physiography, &c.).

J. Howard (Islington). Robt. Steele.
J. Hughes. *Isaac S. Scarf.*
John J. Pilley. *Edwd. Riley.*
R. H. Harland. *Vivian B. Lewes.*
Walter N. Edwards. *A. J. de Hailes.*
E. J. Cox.

Moorwood, Colin Francis,

260, Barnsley Road, Sheffield.

Analytical Chemist. For five years Assistant to James Taylor, Esq., B.Sc., Metallurgist; afterwards connected with the Basic Bessemer process, and at present acting as Chemist to a firm of Steel Manufacturers.

James Taylor. W. B. Bottomley. W. H. Greenwood.
Fredk. J. Merrils. *J. Hall Worrall.*

Nickolls, John Bate,

8, Grange, Guernsey.

Analyst and Natural Science Lecturer. Public Analyst for Guernsey. Nat. Science Lecturer at Highgate College, Guernsey. Member Society Public Analysts, Mem. Soc. Chemical Industry, Mem. Pharmaceutical Society.

John Muter. G. Bult Francis.
W. A. H. Naylor. A. E. Barclay.
L. de Koningh. Matthew A. Adams.

Ramage, Hugh,

Royal College of Science, Dublin.

Assistant Chemist. Associate of the Royal College of Science. Associate of the Institute of Chemistry. Assistant Examiner in Chemistry, Science and Art Department.

W. N. Hartley. W. E. Adeney. Jos. Reddrop.
M. H. Foye. Thos. A. Shegog.

Robson, James,

1, Maxwell Street, Paisley.

Chemist. Studied in Anderson College for three years. Six years and a half Assistant to the late Professor Dittmar, three of which Senior Assistant. Reappointed by Professor Henderson, D.Sc.

G. G. Henderson. Edmund J. Mills.
Alex. Crum Brown. Chas. A. Fawsitt.
John McArthur.

Rodger, James Wyllie,

76, Anerley Park, S.E.

Assistant Lecturer in Chemistry, Royal College of Science, South Kensington. Associate of the Royal College of Science. First Royal Scholar in Session 1884–85: joint author with Professor Thorpe of papers on "Potilizin's Law of Mutual Displacement of Chlorine and

Bromine" (Proc., 1888, p. 20) and on "Thiophosphoryl Fluoride" (Trans., 1889, p. 306).

T. E. Thorpe.
Percy F. Frankland.
Chapman Jones.
F. R. Japp.
W. P. Wynne.
A. E. Tutton.

Rudolf, Norman Scott,

Sewan, Sarun, Bengal, India.

Analytical and Consulting Chemist. Bachelor of Science with Honours in Chemistry of Victoria University. Passed examination for Associateship of Institute of Chemistry. First Silver Medal from City and Guilds of London Institute for proficiency in the Chemistry of Fuel; also passed the examination of above Institute with Honours in Alkali. Certificate for proficiency in Technology from University College, Liverpool.

J. Campbell Brown.
Herbert B. Stocks.
Charles A. Kohn.
S. G. Rawson.
W. Collingwood Williams.

Sarbadhicary, Satyaprasad,

53, Wellington Street, Calcutta.

Manager, Oriental Apothecaries' Hall, 1, College Street, Calcutta Was brought up in the Calcutta Medical College. Is now the Manufacturing and Analytical Chemist to the Oriental Apothecaries' Hall, an old established and respectable firm of Pharmaceutical and Analytical Chemists.

Kanny Loll Dey.
Taraprasanna Roy.
G. C. Bose.
Preo Lall Dey.
Ramchandra Dutta.
F. N. Macnamara.
J. Bell.

Schloesser, Augustus, Ph.D., M.Sc.,

7, Victoria Crescent, Busby, near Glasgow.

Lecturer on Chemistry. Dissertation, "Condensation von Benzoylessigester mit bernsteinsaurem Natrium." With W. H. Perkin, Ph.D., F.R.S., "Diphenylfurfuran" (*Journ. Chem. Soc.*, **57**, 944).

W. H. Perkin, jun.
James Stenhouse.
G. G. Henderson.
A. G. Perkin.
A. Humboldt Sexon.
F. M. Perkin.

Sell, William James,

1, Bene't Place, Cambridge.

Demonstrator of Chemistry. First Class (Chemistry) Natural Sciences Tripos, 1876. For many years Senior Demonstrator at the

University Laboratory, Cambridge. Papers: (1) "On the Volumetric Estimation of Chromium" (*Chem. Soc. Trans.*, 1879, 292); (2) "On a Series of Salts of a Base containing Chromium and Urea." Part I (*Proc. Roy. Soc.*, No. 218, 1882); (3) "On a Series of Salts of a Base containing Chromium and Urea." Part II (*Proc. Roy. Soc.*, **45**, 321); (4) "Volumetric Determination of Chromium" (*Chem. News*, **54**, 299).

G. D. Liveing. H. J. H. Fenton. James Dewar.
Alexander Scott. T. H. Easterfield.

Shaw, George Arthur,
112, Bramhall Lane, Stockport.

Manufacturing Chemist (Kay Brothers, Limited). Pharmaceutical Chemist. Have passed Major and Minor Examinations of the Pharmaceutical Society. Two years Student in Chemistry at the Stockport Technical School (1889–91). One year Student of Chemistry and Practical Chemistry in the School of the Pharmaceutical Society, where I was awarded the Silver Medal in Practical Chemistry, and two Certificates of Honour in Chemistry.

M. Carteighe. Wyndham R. Dunstan.
Thomas S. Dymond. John Attfield.
R. J. Brown.

Shepherd, Reginald des Forges,
6, Coltman Street, Hull.

Three years in the Chemical Laboratories of the Owens College; B.Sc., with Honours in Chemistry, Victoria University.

Harold B. Dixon. Arthur Harden. P. J. Hartog.
G. J. Fowler. G. H. Bailey. *James Grant.*

Spackman, Charles,
Sileby, Loughborough.

Chemical Engineer. From 1873 to 1878, working under the late Gen. Scott, F.R.S., at experiments on sewage treatment, and on limes and cements. From 1879 to 1882, Chemist to the Folkestone Cement Company. During 1883, Engineer for the erection of Barrow Cement Works, near Loughborough. Since then, and at the present time, Resident Engineer and Chemist at these works. Full students' lecture course and laboratory work at University College, Nottingham. Communicated two chemical papers to the *Jour. Soc. Chem. Ind.*

R. Lloyd Whiteley. Frank Clowes.
L. Archbutt. J. B. Coleman.
Frank T. Addyman. *M. J. R. Dunstan.*

Speidel, Ernst, B.S.,

Nos. 17, 19, 21, Quincy Street, Chicago, Illinois.

Analytical and Consulting Chemist. One year as Assistant in Chemical Manufactory. Six years as Chemist in Testing Laboratories of the C., B., and Q.R.R. and C. and N.W. Railroad. One year Chemist in charge Opaque Cloth Works. Expert in colours and oils.

John A. Miller. Edw. Gudeman.
H. A. Wetzel. *Ch. F. Chandler.*
Elwyn Waller.

Turton, Albert Hy.,

Ashleigh, Carlyle Road, Edgbaston, Birmingham, and Launceston, Tasmania.

Pharmaceutical Chemist, Assayer, and Metallurgical Chemist. Certificated Chemist of Tasmania, and Member of its Pharmaceutical Society also. Member of South Australian Pharmaceutical Society. Student in the Metallurgical Laboratory, Mason College.

Thomas Turner. Alfred Hill. Chas. Hunt.
W. F. Haydon. *Geo. S. Albright.*

Warry, John King,

15, Grafton Street, Mile End.

Doctor of Medicine. Deputy Medical Officer of Health and Public Analyst for Hackney.

Frederic Jas. M. Page. J. Hugh Bicket.
E. Francis Smith. Theodore Maxwell.
George Robertson.

Westaway, Frederic William,

1, Aytoun Road, Stockwell, S.W.

Lecturer at Stockwell Pupil Teachers' School, S.W. B.A. (London). Holder of 12 Advanced Science Certificates from the Science and Art Department, including Theoretical and Practical Chemistry. Student and Teacher of Chemistry and Natural Science since 1884. Just appointed Director of Technical Instruction under the Dalton-in-Furness School Board.

George Collar. Wm. B. Hards.
James Hall. *J. H. Gladstone.*
H. R. Hind.

Whiteside, Jno. Lowe,

51, Cannon Street, Bolton.

Chemical Lecturer. Teacher of Chemistry (Organic and Inorganic) from 1879 at the Bolton Church Institute to present time (31 benches).

Teacher of Metallurgy, and Head of the Bleaching, Dyeing, and Printing Department at Bolton Technical School.

George H. Hurst. W. B. Mason. H. E. Roscoe.
Ernest Bentz. *R. W. Walker.*

Wigham, Frederick Henry,

25, Pinderfield Road, Wakefield.

Analyst and Metallurgical Chemist. Four years Assistant with Messrs. Pattinson and Stead, of Middlesbrough. Three years Analyst with Messrs. G. Cradock and Co., Wakefield.

J. E. Stead. H. Frankland. E. H. Saniter.
C. H. Ridsdale. *John Pattinson.*

Williams, William,

Smithfield Street, Dolgelly, N. Wales.

Medical Practitioner and Lecturer in Hygiene to the University College of Wales, Aberystwith. Late Assistant M.O. of Health to Shropshire. M.A. (Oxon.), with First Class Honours in Natural Science (Chemistry); late Demonstrator of Chemistry in the Chemical Laboratory, Oxford; M.B., B.Ch., and D.P.H. (Oxon.); M.R.C.S. (Eng.); L.S.A. (Lond.).

William Odling. W. W. Fisher. John Watts.
V. H. Veley. *D. H. Nagel.*

Wilsmore, N. T. M.,

Altona, Orrong Road, Elsternwick, Melbourne.

Student. Bachelor of Science in Chemistry, University of Melbourne; "Researches on the Organo-Metallic Compounds," contributed to the Third Meeting of the Australasian Science Association and to the Chemical Society.

Orme Masson. J. B. Kirkland. C. R. Blackett.
George Foord. *Robert Barton.* *Francis R. Power.*

The following Candidates are recommended by the Council for ballot under Bye-law I (para. 3):—

Campbell, Andrew,

c/o Burmah Oil Co., Rangoon.

Analytical Chemist. Four years Assistant to J. Falconer King, Esq., F.I.C., City Analyst, Edinburgh. Chemist to Linlithgow Oil Co., Limited. Managing Chemist to the Burmah Oil Co., Limited, Rangoon.

J. Falconer King. John Hunter.
James C. Hamilton.

Williams, Jno.,

Georgetown, Demerara.

Private Assistant to Government Analytical Chemist, British Guiana. Five years' study in Chemistry under the late Professor Francis, F.C.S., F.I.C., Government Analyst, and two years under Professor J. B. Harrison, F.C.S., F.I.C., Government Chemist. Acted as Assistant Government Chemist during the absence on leave of the Government Chemist from September 1891, to April, 1892.

J. B. Harrison. William Douglas.
H. Armody. *Francis Watts.*
John R. Bovell.

HARRISON AND SONS, PRINTERS IN ORDINARY TO HER MAJESTY, ST. MARTIN'S LANE.

Issued 9/12/1892.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

No. 116. Session 1892–93.

December 1, 1892. Professor A. Crum Brown, F.R.S., President, in the Chair.

Drs. William J. McKerrow, John Shields, James Walker and W. P. Wynne were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. John Edwin Brockbank, The Croft, Kirksanton, *viâ* Carnforth; Edward Brooke, West Court, Chalk, Gravesend, Kent; Charles Dreyfus, Ph.D., Clayton Aniline Co., Clayton, Manchester; James Elias, Briton Ferry, Glamorganshire; Alexander Stanley Elmore, Twaite Gate, Leeds; George Neville Huntly, 56, Sheen Road, Richmond, Surrey; Charles M. Luxmore, B.Sc., 529, Battersea Park Road; Robert Henry Owen, Pas-y-coed, Troedyrhiw, near Merthyr Tidfil; John William Towers, Brantwood, Allerton, near Liverpool; William Ernest Wheeler, Cumberland House, Meynell Road, South Hackney.

Of the following papers those marked * were read:—

*70. "The isolation of two predicted hydrates of nitric acid." By S. U. Pickering.

In the case of nitric acid the curves plotted from both Berthelot's and Thomsen's heat of dissolution values were found to exhibit a well-marked "break" at the composition of the *trihydrate;* Kolb's density values afforded a similar indication, and also exhibited a "break" at the *monohydrate;* on making a series of freezing point determinations, both these hydrates, but no others, were isolated in the crystalline condition. The melting point of the trihydrate is −18·2° and that of the monohydrate −36·8°. In the case of each the melting point is lowered by the addition of either acid or water.

These results are regarded by the author as an important confirmation of the views expressed by him in previous papers.

71.* "Anhydrous oxalic acid." By W. W. Fisher, M.A.

Although the crystallised dihydrated acid is a familiar substance, anhydrous oxalic acid is but little known, except as a roughly dried mass, probably because it so readily attracts moisture. E. Reichert has shown that it is obtained from the hydrate by treatment with concentrated sulphuric acid (*Jena. Zeit.*, 1864, vol. 1, p. 244), but he states that the excess crystallising from a heated mixture of the two substances is a hydrate—this, however, appears to be an error. A. Villiers, in 1880 (*Compt. rend.*, **90**, 821), published a note on the crystals obtained by this method, and pointed out that they were of greater relative density than sulphuric acid. The crystalline form of the anhydrous acid has been described and figured by Löschmidt (*Wien. Akad. Ber.*, 1865), but owing to the readiness with which the crystals change in air, the determinations were but approximate; they are prismatic octahedra, resembling elongated crystals of alum.

The best method of producing the crystals is to allow ordinary hydrated oxalic acid to remain in contact with concentrated sulphuric acid for a few months; if the two substances are sealed up together in a glass tube, beautiful specimens may be obtained. Oxalic acid, whether hydrated or not, is sparingly soluble in sulphuric acid, about 3 per cent. being taken up by the cold liquid. The anhydrous acid dissolves with a slight fall of temperature, while a rise of temperature is noticed when the hydrated crystals dissolve. Dissolution takes place readily on warming, and part of the dissolved acid separates in the anhydrous state on cooling the solution, a supersaturated liquid being obtained from which the excess is slowly deposited.

The relative density of the crystals, determined in dry petroleum, was found to be 1·878 compared with water at 4°, while the density of the hydrated acid similarly determined was found to be 1·608 (Bödeker, *Jahresb.*, 1860, 17, gives $d = 2·0$). This difference affords a ready means of distinguishing the hydrated crystals, as when placed in concentrated sulphuric acid they at first float, but losing their transparency and turning white as they become dehydrated, they increase in density and finally sink to the bottom.

The limit of concentration at which crystallised oxalic acid in contact with sulphuric acid retains its water is between 60 and 70 per cent. at ordinary temperatures, as the hydrated form is unchanged in the weaker acid and the anhydrous crystals are permanent in the 70 per cent. sulphuric acid.

Hydrated oxalic acid behaves in a similar manner towards nitric acid, as it may be recrystallised from that containing about 70 per cent. of real acid ($d = 1·2$) without losing its water, while in a highly-concentrated acid ($d = 1·50$) it is dehydrated.

The crystals deposited from nitric acid are usually less brilliant in appearance and smaller than those formed in sulphuric acid.

Commonly, oxalic acid is dried by the rough method of heating in an open dish, when a considerable part of the water is expelled, but much loss takes place by volatilisation, and unless the acid be actually sublimed the drying is still imperfect. It can, however, be easily and completely dried in a vacuum by means of the arrangement described by McLeod (*C. S. Trans.*, 1883, 384) or in an ordinary retort; for this purpose, the retort containing the acid is attached to a receiver containing strong sulphuric acid, exhausted by a water vacuum-pump, and heated at 60° on a water-bath; in a few hours the theoretical quantity of water is expelled from the crystals.

A specimen dried in this manner, which had been transferred to a tube, then sublimed in a vacuum by a steam heat and sealed up in the year 1890, appeared in the ordinary form of the sublimed acid as a mass of needles, but after a few months, by slow resublimation at ordinary temperatures, the interior of the tube became coated with brilliant crystals resembling those deposited from sulphuric acid.

The volatility of hydrated oxalic acid was observed by Faraday (*Journal Royal Institution*. 1830), who found that when kept in an open tube for four years within a stoppered bottle containing calcium chloride, some oxalic acid passed over into the calcium solution, and new crystals were visible on the surface of the old ones. The hydrated acid does not appear to sublime as readily as the anhydrous form, specimens enclosed in vacuous tubes showing, after several months, hardly any signs of volatility.

The stability of oxalic acid is evidenced by the fact that it can be readily sublimed in a vacuum at temperatures up to 150°; and that, even if heated on the water-bath in concentrated sulphuric acid, a portion will sublime from the liquid undecomposed.

Anhydrous oxalic acid will dissolve in warm ethylic oxalate or glacial acetic acid, but does not crystallise well from either solvent, only a powdery product being obtained.

*72. "The production of orcinol and other condensation products from dehydracetic 'acid.'" By N. Collie, Ph.D., and W. S. Myers, B.Sc.

Oppenheim and Precht have stated (*Ber.*, 1876, 324) that orcinol is formed when dehydracetic "acid" is hydrolysed by means of barium hydrate, but they obtained only a very small quantity, and based their conclusion on qualitative evidence; their observation is now corroborated by the authors, who have obtained orcinol, not only from dehydracetic "acid" and dimethylpyrone by the action of barium hydrate, but also by boiling a mixture of syrupy caustic soda and dehydracetic "acid;" in the latter case. a true (carboxylic) acid is first produced, which loses carbon dioxide. leaving orcinol.

Among the products obtained on submitting diacetylacetone to the action of barium hydrate, the authors have discovered a substance crystallising in bright *yellow* needles melting at 180—181°, which is probably a naphthalene derivative, its formation involving the change expressed in the equation $2C_7H_{10}O_3 = C_{14}H_{14}O_3 + 3H_2O$. Mention is also made of a substance exhibiting a magnificent *blue fluorescence* formed in the preparation of diacetylacetone from dimethylpyrone by treatment with baryta water.

An *amidodehydracetic "acid"* is described, which is formed by the interaction of solid dehydracetic "acid" and the strongest ammonia solution; it crystallises in long silky needles, m. p. 192—196°, and is readily reconverted into dehydracetic "acid" by alkaline or acid hydrolysis.

*73. "Observations on the origin of colour and on fluorescence." By W. N. Hartley, F.R.S.

Adverting to the arguments used by Armstrong in these 'Proceedings' (1888, 4, 27) the author defines colour and the cause of colour, the nature of visible and invisible colour, and the limits of visibility in the spectrum from a physical standpoint. It is contended that it cannot be stated in general terms that colour is due to special modes of atomic arrangement, but that the statement may be applied in a restricted sense to certain carbon compounds, especially to those included in the class to which organic dye-stuffs belong; and it is pointed out that *all open chain hydrocarbons exert a continuous absorption the extent of which depends on the number of carbon atoms in the molecule.*

Attention having been drawn by Armstrong to the condition of strain and of instability existing in many coloured substances, it is pointed out that this is owing to their being all endothermic compounds; that ethylene, acetylene and benzene are endothermic, but that derivatives of the last-named only are coloured; and finally that *all organic colouring matters are endothermic compounds.*

This is considered to be the physical cause of that which Armstrong has not defined but which he terms "reactivity" or "high potential."

It is next shown that anthracene is not colourless but has a true greenish-yellow colour in addition to its fluorescence.

The results of a number of experiments on fluorescence are then given in detail, and from these the following conclusions are drawn:—

1. Quinine dissolved in alcohol exhibits a beautiful, bright violet fluorescence.
2. Chlorhydric acid is not fluorescent.
3. Quinine hydrochloride is very feebly fluorescent, but without distinct colour.
4. Chloroform is feebly fluorescent, but without distinct colour.
5. Both chlorhydric acid and chloroform can extinguish those rays which are the cause of the fluorescence in quinine.
6. Some alkaloids may be recognised by the degree and colour of the fluorescence they exhibit.
7. Normal alcohols of the ethylic series are fluorescent; so, also, are the fatty acids.
8. Glycerol has a violet fluorescence.
9. Benzene has a pale blue fluorescence, azobenzene a greenish-blue.
10. Rock crystal has a pale bluish-violet fluorescence, flint glass a strong blue, and crown glass a very brilliant and beautiful blue fluorescence.
11 Substances which are not fluorescent in strong solutions may become so on dilution, particularly if they exert a very powerful absorption of the ultra-violet or visible spectrum.

The colour and fluorescence of anthracene are explained. Finally, the case of ortho- and para-nitrophenol and of meta- and para-nitraniline are discussed and it is contended that the formulæ of orthonitrophenol and metanitraniline should not at present undergo modification.

*74. "The origin of colour. V. Coloured hydrocarbons and fluorescence: a reply to Professor Hartley's observations on the origin of colour and of fluorescence." By Henry E. Armstrong.

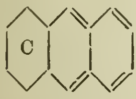
A perusal of my friend's objections leaves me under the impression that he scarcely apprehends my views on the origin of colour, and that he does not fully comprehend my aim; but this is not surprising, my arguments having hitherto been published in the briefest and most condensed form, as I have always felt that, in dealing with so difficult and extensive a subject, it was necessary to proceed slowly, and to read, mark, learn and give much time for inward digestion and further experimental study before venturing to discuss in detail the manifold issues involved. My critic having clearly accentuated many of the points which demand consideration, I am in consequence much indebted to him; moreover the fact that he has paid special attention to the study of ultra-violet absorption spectra lends great weight to his statements, which serve also to indicate the departure from current views involved in the adoption of the hypothesis of which I am an advocate. I have never left out of account the fact that, in a physical sense, all substances are coloured—all substances possessing the power of absorbing the light waves, either generally or selectively in some part either of the visible or invisible spectrum. My contention has been simply that, confining our attention to visibly coloured organic substances, to substances coloured in the ordinary conventional sense, it is a most remarkable fact that in those cases in which the "constitution" of the coloured substance is fairly well established, coloured substances are all of one type; and from this base I have started on the enquiry whether all coloured organic compounds are not similar in type.

According to Hartley, "in order to study the origin of colour, we must first consider the case of colour in those molecules which are of the simplest possible constitution, such as, for instance, the molecules of chlorine, oxygen, ozone and water." Undoubtedly this would be the case if we knew their "constitution;" but we do not, our knowledge being confined to the fact that their molecules consist of a certain number of atoms—which is insufficient. He also asserts that "the colour or effect on light caused by molecules of oxygen, ozone and water is in no way different from that caused by molecules of aniline blue." This may or may not be a correct interpretation of the facts; apparently the molecules of both oxygen and ozone are intrinsically coloured, but is the water molecule? It is an important question for experimental investigation whether water in a perfectly gaseous state would be blue when viewed in a column of sufficient thickness; its colour may originate in the poly-molecules which presumably are contained in the liquid.

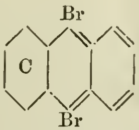
My critic furthermore states that "all organic colouring matters are endothermic compounds." This may well be the case, but the converse does not hold, as he himself recognises, and the conclusion helps us but little; such a phrase, in fact, serves but to obscure the issue by merging the less in the greater.

A most important section of the paper under notice is that relating to fluorescence, describing a series of observations which lead their author to conclude that many substances are fluorescent which hitherto have not been considered to be so, *e.g.*, alcohol and its homologues, &c. There can be no question as to the accuracy of these observations, but until many of the substances have been further studied, and every possible precaution has been taken to obtain them *pure*, I must, with all deference, decline to accept all the results as final. In the case of naphthalene derivatives, especially the naphthylamine- and naphthol-sulphonic acids, with which I am somewhat familiar, intensely fluorescent solutions are the rule—yet I very much doubt their being fluorescent, having noticed, time after time, that the more nearly pure the substance becomes, the less fluorescent it is. It is easy also to account for the presence of fluorescent impurities in these cases on the assumption that during the heating with sulphuric acid oxidation takes place, and that the resulting phthalic acid, or nearly allied compound, condenses, forming a fluorescein; a strong argument in favour of this explanation is afforded by the fact that the disulphonic acids which are formed with the aid of fuming acid at somewhat elevated temperatures, and are very soluble, and therefore difficult to purify, are far more strongly fluorescent than the monosulphonic acids, which are difficultly soluble and comparatively easily purified.

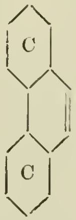
In considering the "origin of fluorescence" and in regarding it as the "beginning of colour," I am, undoubtedly, entering into a highly speculative region; yet the facts are very striking. A single example will suffice. Anthracene is intensely fluorescent, and it may be represented by a quinonoid formula; the isomeric hydrocarbon, phenanthrene, however, which cannot be so represented is colourless and non-fluorescent, according to present knowledge. Hartley's discovery that anthracene has a visible slight, greenish-yellow colour is to me one of extreme interest, and I cannot refrain from referring to it as a very strong confirmation of my hypothesis. Furthermore, while an intense, yellow colour is produced by "weighting" what may be termed, for convenience, the "quinonoid radicles" of anthracene by introducing chlorine or bromine in place of the central hydrogen atoms, no such effect follows the introduction in a similar manner of bromine into phenanthrene, dibromophenanthrene being colourless like the hydrocarbon. And yet anthraquinone and phenanthraquinone are both coloured, the latter being deep orange and the former yellow.



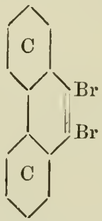
Anthracene.



Dibromanthracene.

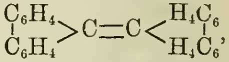


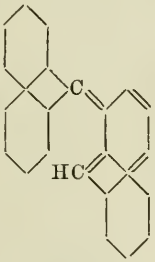
Phenanthrene.



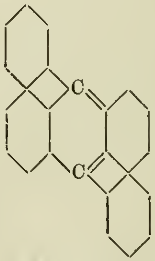
Dibromophenanthrene.

Much more evidence of this character might be adduced, but I have said sufficient to show why Hartley's arguments have not shaken my conviction that we may eventually be led to regard fluorescence as a feeble manifestation of that which we ordinarily describe as colour.

While speaking of anthracene as a coloured hydrocarbon, reference may be made to other coloured hydrocarbons, of which we now know several, viz., carotin, and the red hydrocarbon, $C_{26}H_{16}$, obtained by van Dorp and de la Harpe by passing fluorene over heated lead oxide, which has recently been reinvestigated by Graebe (*Ber.*, 1892, 3146). We know nothing of carotin at present. Graebe represents the hydrocarbon from fluorene by the formula  $\begin{matrix}C_6H_4\\|\\C_6H_4\end{matrix}>C=C<\begin{matrix}H_4C_6\\|\\H_4C_6\end{matrix}$, and therefore terms it dibiphenylenethene ; I venture to suggest that it would be more appropriately named *Erythrophene*, a term which does not commit us to any definite view as to its constitution. I have no hesitation in asserting that a hydrocarbon represented by the formula proposed by Graebe would be colourless, and I would suggest the formula given below as more probable; at the same time, it may be pointed out that the *yellow* hydrocarbon $C_{26}H_{14}$ (*xanthophene*) which van Dorp and de la Harpe obtained together with "erythrophene" may be a diphenylenated anthracene.



Erythrophene.



Xanthophene.

Both hydrocarbons are represented by quinonoid formulæ and the "quinonoid radicles" are heavily "weighted"; hence they are somewhat intensely coloured.

As to the nitrophenols, I have not called in question the constitution of the ortho-compound simply because it has a yellow colour: I have also pointed out that it differs in many other respects in a marked manner from its isomerides. Hartley's remarks appear to me in no way to affect my argument. With reference to the nitro-compounds, he states that "a very little shifting of the region of absorption to rays a little more or a little less refrangible makes such substances colourless or coloured." No doubt this is so, but the question I would raise is whether the shifting necessary for the production of visible colour (and in a measure of fluorescence) is not conditioned by a special character of structure. In such a case as that of diorthonitrophenol, for example, which is yellow and affords intensely red metallic derivatives, yet yields colourless ethers, it is very difficult to avoid the conclusion that this is so: if we consider the propyl and potassium derivatives, the change from colour to colourlessness, or *vice versâ*, cannot be conditioned by a change in "weight" of the radicles, as they are so nearly alike in this respect; Hartley, I imagine, would attribute the difference to the higher "energy" of the metallic radicle, but this latter idea is also, in a measure, included in my suggestion that colour in such a case is developed as a consequence of an isodynamic change, and it must not be forgotten that the evidence of changes of this character occurring is rapidly increasing in volume, *e.g.*, Perkin's recent observations on the magnetic rotation of compounds supposed to contain acetyl.

Hartley's explanation of the non-fluorescence of quinine hydrochloride—that it is due to the absorption by the hydrogen chloride solution of the very rays which are the cause of the fluorescence in quinine—is both simple and satisfactory, and I have no hesitation in accepting it; but this in no way alters my conviction that the fluorescence of quinine itself is in all probability conditioned by peculiarity of structure.

Finally, I do not understand why "analogy" should lead us to expect hydrogen chloride to be coloured because chlorine is, or nitric acid to be coloured because NO_2 is; in such cases, we have, I think, at present no reason to expect analogous behaviour, nor indeed any information at our disposal from which conclusions can with justice be drawn.

In the discussion on a previous occasion (these Proceedings, 1892, 105), I said that it appeared probable to me that ultimately colour would be traced *to that peculiar condition represented conventionally by a double bond*, the atoms being regarded as altogether subordinate. It is perhaps desirable that I should now more fully explain my views as to the manner in which the "quinonoid mechanism" conditions colour.

Briefly, I would suggest that in quinonoid compounds there are two "*colour centres*," corresponding to and expressed by the symbol $\overset{\frown}{\smile}$ in formulæ such as I have used in representing coloured substances. These centres, I imagine, co-operate in producing colour through interaction of the light-waves which have traversed them. Substances in which there are no such co-operating centres may absorb generally or selectively in "ultra" and "infra" regions of the spectrum, but without exhibiting "visible colour." In this manner, it is possible, I think, to account for the appearance of colour in substances like diacetyl, Me·CO·CO·Me, and dibenzoyl, Ph·CO·CO·Ph, in which there are two contiguous $C\overset{\frown}{\smile}O$ groups—*i.e.*, which possess a pseudo-orthoquinonoid structure without being quinones.

The colour centres may be likened to elastic gratings, in order to represent the modifications induced by attaching different radicles; in order to account for variation in shade of colour, such elastic gratings may be pictured as undergoing "longitudinal" and "lateral" deformations, varying in extent and character according as the "weight" and character of the attached radicles is varied, and as capable, therefore, of differently affecting the incident rays. However incorrect, from a physical standpoint, this imagery may appear, I trust it will suffice to make my meaning clear.

It is not inconceivable that the distinction which I have sought to make between visible colour and physical colour is no arbitrary one, but is inherent in the human optic mechanism; that our perception of colour, in fact, is itself conditioned by, and exerted through, the agency of quinonoid matters. The discussion of the origin of colour from this point of view appears, therefore, to be of importance to physiologists, as well as to chemists and physicists.

*75. "The origin of colour. VI. Azobenzene." By Henry E. Armstrong.

A compound represented by the formula $C_6H_5{\cdot}N{:}N{\cdot}C_6H_5$ obviously does not come within my "colour rule," and should, in fact, be colourless: yet azobenzene is a brilliantly orange-red coloured substance; moreover, the formulæ usually attributed to the diazo-salts—*e.g.*, diazobenzene chloride, $C_6H_5{\cdot}N{:}N{\cdot}Cl$—represent these as comparable in constitution with azobenzene, yet they are colourless: hence I have long doubted the correctness of the formula attributed to azobenzene.

Werigo, in a paper, "Ueber die Additionsfähigkeit des Azobenzids" (*Annalen*, 1872, **165**, 189), has drawn attention to the readiness with which azobenzene forms addition compounds, and describes a hexabromide; he also states that it affords a *colourless* tetrabromo-substitution derivative. At my request, Mr. E. Mills has undertaken to revise Werigo's observations and to study the bromo- and other derivatives of azobenzene in detail, as these promise to be of considerable interest.

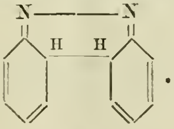
It appeared not improbable that Werigo's hexabromide belonged to the diazo-perbromide class, but this, it seems, is not the case; by treating it with ammonia, Mr. Mills has obtained only bromo-substitution derivatives of azobenzene—chiefly diparabromazobenzene—no *azoimide* being formed (*cf.* Meldola and Hawkins, these Proceedings, 1892, 133). He has confirmed Werigo's statement that when bromine acts on a hot alcoholic solution of azobenzene, a *colourless* tetrabromo-derivative is produced, which, on reduction, yields a tetrabromobenzidine apparently identical with that prepared from benzidine by Claus and Risler; and as he has not succeeded in obtaining the colourless tetrabromo-compound from diparabromazobenzene, there can be little doubt that none of the bromine atoms in the tetrabromo-derivative are in para-position to the nitrogen atoms.

Experiments made with the object of preparing alkyl derivatives of hydrazobenzene have hitherto been unsuccessful; when boiled with zinc chloride and alcohol, it yields benzidine.

As the introduction of bromine into a coloured compound usually has the effect of heightening the colour, the conversion of azobenzene into a colourless bromo-derivative would seem to indicate that in some way the type changes: the tetra-derivative may well be a compound of the formula $C_6H_3Br_2{\cdot}N{\equiv}N{\cdot}C_6H_3Br_2$.

The formula generally attributed to azobenzene may, therefore, be regarded as unsatisfactory *not only* because it is a coloured substance, but also because it combines with bromine, &c., with a readiness which is unusual in the case of mono-derivatives of benzene; because it yields a considerable proportion of a *meta*-monobromo-derivative and of a higher bromo-derivative in which, apparently, none of the bromine atoms are in *para*-positions, an altogether unusual circumstance in the case of benzene mono-derivatives other than those containing *acid* radicles; and because it yields a *colourless* tetrabromo-derivative.

The following formula would "account" for all these peculiarities, and in a measure "explain" the formation of benzidine and diphenyline as well as the recent remarkable observations on the production of diphenylamine derivatives from azobenzenoid compounds on reduction; but it is eminently unconventional, and its adoption involves the recognition of a form of interaction not yet entertained by chemists:—

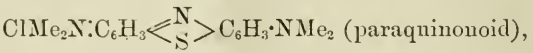


Discussion.

Mr. Green considered that the relation of constitution to colour was a very important question both from a theoretical and practical point of view. The "quinonoid" hypothesis advocated by Dr. Armstrong appeared to him to be the only satisfactory attempt which had been hitherto made to formulate a complete theory of chromogenesis. Witt and others had given us chromophores, chromogens, and auxochromes, but these ideas were more names than theories, as no one had yet been able to predict what groups would be chromophores and what not. The "quinonoid" hypothesis, however, put us fairly on the road to predicting whether a compound of a certain constitution would be a dye-stuff or not, and might even eventually lead to the prediction of the shade and dyeing properties. He had given a good deal of attention to the subject recently, and although he had begun by regarding the "quinonoid" theory in a somewhat sceptical light, it had recommended itself to him more and more, as he found so many facts, hitherto inexplicable, which were explained perfectly simply by its means. He might instance the formation of rosaniline in the magenta-melt, which was readily explained by assuming the primary formation of an oxidation product of paratoluidine, viz., $H_2C{:}C_6H_4{:}NH$, which might then undergo alternate additions of aniline and reoxidations. He believed he had obtained this parent substance of the rosaniline series by oxidation of paratoluidine sulphate in acid solution, and it appeared to be identical with a substance described by Dr. Perkin as an isomer of parazotoluene. Again, the well known tendency of quinones to form substituted amidoquinones with amines explains the ready formation of such complicated products as safranine, the indulines, aniline-black, &c.

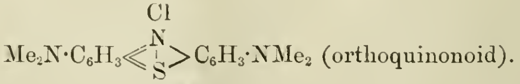
He was inclined rather to attribute the cause of the colour in such "quinonoid" compounds to a strain set up within the benzene nucleus by two of the bonds ceasing to act centrally, than to the arrangement of these bonds outside the nucleus, *i.e.*, as *intra*-nucleal rather than *inter*-nucleal.

On the "quinonoid" hypothesis, two groups of colours should be possible, viz., "ortho-colours" and para-colours." The colours of the rosaniline series can only be formulated as para-colours, indigo only as an ortho-colour. On the other hand, many of the artificial colouring matters may be viewed either as para- or ortho-colours; thus methylene-blue may be written:—



$$ClMe_2N{:}C_6H_3\lll\substack{N\\S}>C_6H_3\cdot NMe_2 \text{ (paraquinonoid),}$$

or



$$Me_2N\cdot C_6H_3\lll\substack{Cl\\N\\|\\S}>C_6H_3\cdot NMe_2 \text{ (orthoquinonoid).}$$

The speaker had recently examined a large number of colouring matters in regard to their behaviour towards reducing agents and the stability of their leuco-compounds, and had brought to light the remarkable fact that, whereas the leuco-compounds of the rosaniline aurin and phthalein colours were very stable, resisting air oxidation, the opposite was the case with the leuco-colours of the azine, oxazine, thiazine, acridine, safranine and induline series, which all oxidise in the air to the corresponding colours with extreme rapidity. This was also the case with leucindigo and its sulphonic acid. The conclusion seemed to him to be irresistible, that the colours of the latter class were *ortho-* colours, whereas, the eosines, aurines, rhodamines, &c., like the rosanilines, were *para*-colours.

Mr. FRISWELL agreed that confirmation of Dr. Armstrong's views was afforded by facts such as, for example, the colourlessness of triamidotriphenylcarbinol in comparison with the intense colour of its anhydro-base, which could be represented by a quinonoid formula. He, however, thought that the representation of colour as characteristic of a particular constitution was, for many reasons, to be deprecated, and that the remarkable effect of molecules external to the potential colour molecule in either developing or suppressing colour required attention. In the case of trihydroxytriphenylcarbinol, an apparently colourless substance, colour was developed by alkali, the salts being powerfully coloured; and in the case of the interesting dye "pure scarlet" discovered by E. C. Nicholson, which the speaker had himself studied, and which he thought was to be represented by the formula $HO{\cdot}C(C_6H_4{\cdot}OH)_2(C_6H_3MeNH_2)$, both acid and alkali salts were coloured, although the substance itself was but feebly coloured.

The sulphonic acids of triphenylrosaniline were powerful colours, but their combinations with alkalis almost colourless: so that wool dyed with the sodium salt of Nicholson-blue was nearly white until dipped into acid. This phenomenon was even more marked in Meldola's alkali-green.

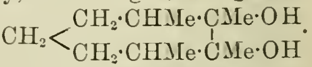
In illustration of the fact that substances exactly similar in constitution behaved in remarkably dissimilar ways, the following experiment was then made:—Two tubes were taken: one contained rosaniline base, benzoic acid and aniline, the other triphenylrosaniline base, benzoic acid and aniline—the latter being of an intense blue, the former a feeble red, colour. On heating to a similar temperature, the rosaniline base combined with the benzoic acid, and the well known magenta colour was produced in the one tube; while, in the other, the triphenylrosaniline base split off from the benzoic acid, and only the dull brownish feeble colour of the base was noticeable. These facts showed:—1, the importance of factors external to the potential colour molecule; 2, the variations of behaviour of substances containing similar potential colour molecules. Hence, he considered time not yet ripe for extensive generalisation as to the origin of colour in the benzene series.

[Mr. Friswell's argument is valid only if proof can be given that the coloured salts he refers to are *carbinolic;* there is no reason to suppose, at present, that the change which attends the formation of the rosaniline salts does not occur in all the cases he mentions in which coloured compounds result.—H. E. A.]

Mr. Jackson enquired whether the vapour of quinone were coloured.

Mr. Ling mentioned that diparaiodoazobenzene had but a pale yellow colour.

76. "The reduction products of dimethyldiacetylpentane." By F. Stanley Kipping, Ph.D., D.Sc.

It is shown that dimethyldiacetylpentane, $CHMeAc\cdot[CH_2]_3\cdot CHMeAc$, a diketone produced by the hydrolysis of ethylic dimethyldiacetylpimelate (Kipping and Mackenzie, *C.S. Trans.*, 1891, 569), is readily converted by reduction into a mixture of approximately equal quantities of dimethyldihydroxynonane, and of a compound which, judging from the manner in which it is formed, may, it is thought, be regarded as tetramethyldihydroxyheptamethylene,  $CH_2<\begin{array}{l}CH_2\cdot CHMe\cdot CMe\cdot OH\\ \qquad\qquad\qquad\;\vert\\ CH_2\cdot CHMe\cdot CMe\cdot OH\end{array}$. When the crude products obtained by heating a moist ethereal solution of the ketone with sodium is submitted to steam distillation, a colourless oil, which has a peculiar and characteristic odour, slowly passes over, leaving as residue an almost odourless, practically non-volatile oil.

Excluding pinacones and other condensation products which might be formed, and which would be characterised by a very high boiling point, only three compounds can be produced by the reduction of the diketone, namely, the above mentioned and the ketonic alcohol $CH_3\cdot CO\cdot CHMe\cdot[CH_2]_3\cdot CHMe\cdot CH(OH)\cdot CH_3$. As the non-volatile oil has the composition $C_{11}H_{24}O_2$, and yields a diacetyl derivative of the composition $C_{11}H_{22}O_2Ac_2$, it is to be regarded as dimethyldihydroxynonane.

The volatile oil is not reduced on treatment of its solution in moist ether with sodium, and is not acted on by phenylhydrazine or hydroxylamine; hence, it cannot be a ketonic alcohol of the constitution given above; it would appear probable, therefore, that it is a tetramethyldihydroxyheptamethylene. This conclusion is borne out by the great similarity in properties between the volatile oil and the dimethyldihydroxyheptamethylene previously described by Kipping and Perkin (*C.S. Trans.*, 1891, 214), a resemblance which cannot fail to be observed when working with the two compounds.

77. "The products of the interaction of zinc chloride or sulphuric acid and camphor. (Third notice.)" By Henry E. Armstrong and F. S. Kipping.

In a previous notice (these Proceedings, 1892, 54), in which it was shown that the crude product obtained on heating camphor with either sulphuric acid or zinc chloride contains 1 : 2 : 4-acetylorthoxylene, reference was made to the presence of a constituent to which presumably the oil owes its strong, peppermint-like odour; all attempts to separate this constituent by fractional distillation were unsuccessful, nor could it be recovered from the oil from which the acetorthoxylene-hydrazone had been separated by crystallisation. As it was observed that the crude oil readily decolorised an acid solution of permanganate, which has but little action on camphor and acetorthoxylene, a quantity of the oil from which these latter had, as far as possible, been separated was submitted to oxidation; ultimately an acid was obtained which has proved to be α-methylglutaric acid. As this acid is the characteristic oxidation product of the phorone obtained by distilling calcic camphorate, according to Königs and Eppen, which has a strong peppermint-like odour, it is very probable that a homologue of this phorone is present in the camphor product, which has a higher boiling point than camphorone.

79. "The Griess-Sandmeyer interactions and Gattermann's modification thereof." By Henry E. Armstrong and W. P. Wynne.

Having very frequently had occasion, during several years past, especially in the couse of our studies of naphthalene derivatives, to avail ourselves of the marvellous improvements effected by Sandmeyer in the Griess methods of displacing the amido-group by halogens, &c., we have been led to carefully study the conditions requisite for success, and have long since come to the conclusion that, in very many cases, much better results may be obtained by operating at relatively low temperatures instead of at the boiling point as recommended in most cases by Sandmeyer. Experiments made at the request of one of the writers by Mr. Conroy with the object of comparing the yield in the case of the conversion of aniline into chloro- and cyano-benzene when operating:—

1, in accordance with Sandmeyer's original directions,
2, in accordance with Gattermann's directions, using finely-divided copper in place of cuprous salt,
3, in general accordance with Sandmeyer's directions, but at lower temperatures,

have led to the conclusion that, in the case of chlorobenzene, an infinitely better yield is obtained by mixing the cooled cuprous with the cooled diazo-solution, subsequently allowing the temperature to rise. It appears also that the Gattermann process affords a larger yield only in so far as it differs from the Sandmeyer process by being carried out at a lower temperature, and that it differs in no other essential particular from the Sandmeyer process; there is, in fact, an entire absence of evidence that the copper acts as such, or except it has undergone conversion into cuprous salt. In the case of cyanobenzene, apparently the same advantage is not derived from carrying on the operation at a low temperature.

The "cold process" has been found to be of advantage in many other cases. Several years ago, the preparation of large quantities of orthochlorotoluene was carried out in the Central Institution Laboratory essentially in the manner described by Erdmann in his recent paper in *Liebig's Annalen*, and the yield was even better than that he obtained. Allusion is made to this in the paper by one of us on toluene derivatives (*cf.*, these Proceedings, 1892, 139) which appears in the December number of the Transactions; several other instances of the application of the cold process are mentioned there.

We are entirely in accord with Erdmann as to the different and peculiar behaviour of the cuprous compounds of various diazo-derivatives; it is especially noteworthy in the case of naphthalene derivatives that the temperature at which nitrogen is evolved varies for each compound, and that there is a temperature optimum at which the conversion should be effected to obtain the maximum amount of pure product. There is no comparison, especially in the case of the naphthylaminesulphonic acids, between the two methods, colourless products being readily and almost immediately obtained by decomposing the diazo-cuprous compound at the favourable temperature, whereas on heating to the boiling point coloured products, which obstinately resist purification, are obtained. There can be little doubt that the formation of "azobenzenes," to which Erdmann directs attention, is, at least, very largely the cause of this coloration. The difficulty met with in converting betanaphthylamine into betachloronaphthalene, which Gattermann has specially noticed, is not got over by the cold process, a very large amount of a resinous condensation product being always formed; a method of obtaining a satisfactory yield of betachloronaphthalene directly from the amido-compound has yet to be discovered.

80. "Methods of observing the spectra of easily volatile metals and their salts, and of separating their spectra from those of the alkaline earths." By W. N. Hartley, F.R.S.

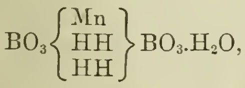
The difficulty in obtaining persistent flame spectra of lithium, potassium, rubidium, cæsium and thallium has to some extent been surmounted by the contrivances designed by Mitscherlich, Gouy, and others, but as solutions are necessary, these methods have not been found satisfactory by the author.

It is shown how flame colorations lasting for long periods may be obtained by converting the salts into fluosilicates, borates, or silicates. These compounds are less readily decomposed, and are more difficult to volatilise than the corresponding chlorides, sulphates, &c. Fused beads of the salts are held in the flame of a Bunsen burner on platinum wires, while measurements are made with the spectrometer.

When observing in the usual manner, the spectra of the alkalis are liable to be obscured by the presence of lines and bands due to the alkaline earths. By converting the material to be examined into a fluosilicate, borate or silicate, the spectra of calcium, strontium and barium are suppressed. If, however, the substance to be examined be converted into a borate, the alkali metals can first be observed, and subsequently by passing hydrogen chloride gas into the flame, the spectra of the alkaline earth metals become brilliantly visible. Although visible, the green bands due to boric oxide are feeble, and cause no confusion.

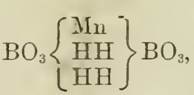
81. "Manganese borate, its constitution and properties." By W. N. Hartley, F.R.S., and Hugh Ramage.

Particulars are given of the properties of manganese borate prepared in various ways from manganese sulphate and alkaline borates. Manganese borate dried *in vacuo* over sulphuric acid is found to lose to the extent of 11·84 per cent. of its weight water when heated at 100°; when heated from 100° to redness, it loses 19·65 per cent., which is water of constitution, the compound being a tetrahydric orthoborate, thus:—



$$BO_3\left\{\begin{matrix}Mn\\HH\\HH\end{matrix}\right\}BO_3.H_2O,$$

Dried *in vacuo.*



$$BO_3\left\{\begin{matrix}Mn\\HH\\HH\end{matrix}\right\}BO_3,$$

Dried at 100°.

$Mn(BO_2)_2$.

Ignited to bright redness.

By gradually heating the salt at fixed temperatures increasing to bright redness, and ascertaining the amount of water which it contained, a series of numbers was obtained from which a curve was drawn, the ordinate numbers being the percentages of water in the compound, and the abscissæ the corresponding temperatures. It was thus seen that there were five points above 100° at which dissociation was interrupted and the compound in existence assumed a condition of stability. The following are the compounds of which the formation is inferred:—

/

Temp. of formation.	Formula of salt formed.	Water contained in compound.	
		Found.	Calculated.
22°	$MnH_4(BO_3)_2\cdot H_2O$	26·86	27·69 per cent.
100°	$MnH_4(BO_3)_2$	19·65	20·33 ,,
170°	$MnH_2B_2O_5$	11·45	11·32 ,,
195—220°	$Mn_{11}H_{20}B_{22}O_{54}$	10·43	10·40 ,,
255°	$Mn_6H_{10}B_{12}O_{29}$	9 71	9·61 ,,
295—305°	$Mn_3H_4B_6O_{14}$	7·20	7·84 ,,
Dull-red heat	$Mn_4H_2B_8O_{17}$	2·87	3·09 ,,
Bright-red Partial fusion.	$Mn(BO_2)_2$	nil	

The solubility of manganese borate in various saline solutions was investigated: it was found to possess a maximum of solubility at or about 18°, and a minimum at 80°, so that when solutions are heated, they deposit the salt at this temperature.

It is believed that this is caused by the dehydration of the salt in solution, namely, $MnH_4(BO_3)_2.H_2O$, which becomes $MnF_4(BO_3)_2$, and this, being less soluble, is deposited: such a change being known to occur, and to be complete at 100° when the salt is heated in air.

54/300 270 30 55

Extra Meeting, December 13th.

An extra meeting of the Society will be held on Tuesday, December 13th, at 8 P.M., the anniversary of the death of Stas. A paper, specially prepared for the occasion by Professor J. W. Mallet, F.R.S., entitled "*Jean Servais Stas, and the measurement of the relative masses of the atoms of the chemical elements*," will be read and discussed.

At the meeting on December 15th, there will be a ballot for the election of Fellows. The following papers will be read:—

"The identity of caffeine and theine." By Prof. Dunstan and Mr. Shepheard.

"Studies on isomeric change." By Dr. Moody.

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PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

No. 117. Session 1892–93.

EXTRA MEETING.—December 13th, 1892. Mr. W. Crookes, F.R.S., Vice-President, in the Chair.

Stas Memorial Lecture.

In opening the proceedings, the Chairman said:—"We are met to-night at an Extraordinary Meeting to do honour to the memory of one of the greatest chemists of this century, I might almost say, one of the greatest chemists ever known to the world. This day is the first anniversary of his death, and it is a very happy thought on the part of the Council of the Chemical Society to hold a meeting on the occasion, in order that you may hear an account given of his labours. I had the very great advantage of being, I might say, a personal friend of Stas. I have been in his laboratory and seen his arrangements and apparatus, and there witnessed, among other things, a large mass of chloride of potassium, which took him years to prepare, with which he had made the most refined experiments without detecting the slightest trace of sodium. I think that fact alone a most wonderful evidence of his marvellous skill."

Dr. Armstrong said, before reading the paper, he desired to state that it was a matter of great regret that it was impossible for Professor Mallet to be present. The Society were none the less much indebted to him, not only for having done what was asked of him, but more particularly for the example he had set. Last year, when a discussion arose as to the steps to be taken to secure appropriate notices of their eminent deceased foreign members Stas and Kopp, the suggestion was made that it would be very desirable to take advantage of these and similar opportunities, not merely to give accounts of the work that our foreign members had done, but inasmuch as the foreign members are always men of great distinction and, as a rule, moreover, men who have lived a considerable number of years after they have accomplished their life work, that such notices should, as far as possible, take the form of critical monographs of the subjects with which they have principally dealt. It seemed that in this way the Society would be doing educational work of very considerable service to its fellows and to chemists generally. The matter was presented to Professor Mallet in this light, and there could be no doubt that he had responded in the most liberal manner possible to the appeal made to him; moreover, it was he who had suggested that a special meeting should be held on the anniversary of Stas' death. The delivery that evening of the first memorial lecture, therefore, was a very important step in the Society's history. It had been arranged that the work of Kopp should be dealt with in a similar spirit by the Treasurer, Professor Thorpe, in February next, on the anniversary of Kopp's death. Furthermore, it was proposed—and he hoped that in May next the proposal would be carried into execution—that, in like manner, on the anniversary of his death, the work of Von Hofmann should be commemorated. At present the plan was not fully developed, but it was somewhat as follows:—In order to deal with the subject from an English point of view, as our German *confrères* in Berlin were also engaged in the preparation of a similar account, it was proposed that Lord Playfair, who was intimately associated in early days with chemical science in this country, should recount his recollections of the state of chemistry at and prior to the time of Hofmann's arrival in England; that Sir Fredk. Abel should follow with an account of the work done at the Royal College of Chemistry under Hofmann, compiling this with the assistance of the remaining friends and pupils of Hofmann; and that the rise and progress of the coal-tar colour industry and its connexion with the Hofmann school should be sketched by Dr. Perkin, who, he was glad to say, had consented to make his contribution to a large extent autobiographical. Whether it would be possible also to include in this memorial notice an analysis of the chief chemical work of Hofmann was not yet decided, this task being one of no slight difficulty and magnitude.

The following paper was read:—

81. "Jean Servais Stas and the measurement of the relative masses of the atoms of the chemical elements." By J. W. Mallet.

The story of the life of Stas is first briefly told, and reference is then made to his researches in other directions than that of his specially chosen investigation of atomic weights; in order to fairly consider the contributions to knowledge in this latter direction which we owe to Stas, Professor Mallet next notices the succession of fundamental ideas which have gradually led up to the question, What is the mass of an atom of a particular element? This historical survey is followed by a lengthy section on the early history of investigations as to the atomic weights of the elements up to the year 1820; after which, reference is made to determinations carried out from the time of Berzelius to that of Stas, a list, in chronological order, of the various published investigations being given.

Stas' work is then considered, the nature of the several general questions of fundamental importance in regard to matter as studied by the chemist, which he endeavoured to settle, being pointed out. These general questions are as follows:—

1. Is the mass, or weight, of an atom of a given element an absolutely constant quantity, so that chemical analysis, properly conducted, must always produce, from each substance examined, strictly the same relative quantities of the same constituents separated?

2. Assuming that the atomic weights of the various elements are severally fixed and immutable, are they represented by numbers which are commensurable, *i.e.*, are the atomic weights of all the other elements integer multiples of that of hydrogen?

3. If we assume the atomic weights of the elements to have constant values and to be represented by commensurable numbers, does not this indicate that all or most of the elements are, in reality, compound forms of matter—that, in short, we are as much called on to believe in the unity and unlimited interconvertibility of matter as in the unity and interconvertibility of energy?

4. Do experiments with substances raised to extremely high temperatures justify the belief that the elements may be dissociated into simpler forms of matter?

The rigour with which Stas investigated the methods of analysis, and the requirements he discovered and applied with a degree of patience and skill never before used in chemical investigation having been somewhat fully referred to, attention is directed to the results arrived at in the course of his elaborate researches.

The titles of his memoirs are given, together with a very lengthy list of the works and papers of other authors dealing with atomic weight determinations.

Professor Mallet then discusses, at considerable length, the objects to be aimed at, and the methods to be pursued in future investigations.

1. Attention is directed to the fact that Stas himself expressed the earnest wish that some other chemist, of sufficiently well established scientific authority, would take the trouble to check, by repetition, some one, at least, of his fundamental results.

2. It is eminently desirable that the work which Stas did for a few of the elements be extended to the entire list of those known—to rare as well as to common elements.

3. Certain of the elements particularly call for a more searching and exact investigation of their atomic weights—tellurium is a prominent example; cobalt and mercury are others: of these, the former may be expected to have a weight intermediate between those of iron and nickel.

4. It is desirable, then, in cases, such as that of iron, for example, in which the accepted value has been determined by study of a single change, should also be determined by other and independent methods.

5. It is eminently desirable that an attempt be made to directly determine the ratio between the atomic weight of hydrogen and that of each of the halogens, without in any way bringing in the atomic weight of oxygen.

6. The uncertainty as regards the elements of the yttrium group, and, in a less degree, those of the didymium group, requires clearing up.

7. It would be well to submit to experiment, by means as refined as those employed by Stas, the question of the absolute exactness of the well-known law of "multiples."

8. Further enquiry into the close approach of so many atomic weights to the integer multiples called for by Prout's hypothesis is required.

9. It is necessary that the apparent periodic relationships among the elements should be discussed, not merely, as heretofore, with the aid of roughly approximate atomic weights, but with exact weights, and, therefore, that more precise determinations of the numbers we would discuss should be made.

In the final section of the paper, the methods which it is desirable shall be pursued in the determination of atomic weights are discussed in detail, under the following heads:—

1. Selection of analytical or synthetical processes.
2. Use of pure materials.
3. Vigilance in regard to extraneous or accidental causes of error.
4. Choice as to the quantities of materials to be used.
5. Practical precautions as to accuracy in manipulation.
6. Precautions in regard to weighings.
7. Measurements by volume of liquids or gases.
8. Calculation of results.
9. Advantage to be derived from the application of greater working force and ampler means than can be commanded by private individuals to the determination of atomic weights. In this section, Pro-

fessor Mallet advocates the establishment of a laboratory in which a small corps of competent chemists should be engaged solely in revising the whole list of atomic weights, with every precaution that could be devised to secure accuracy.

10. Final form of statement of result. In this section, it is argued at length that all atomic masses should be expressed in terms of the mass of the hydrogen atom taken as unity. The adoption of any other basis tends to confuse the consideration of any natural relations between these constants, as has been pointed out by Stas himself in reference to the hypothesis of Prout; numbers which, on the basis of O = 16, come very near to integers, cease to do so when H is taken as unity, and O has its true value, as determined by experiment, assigned to it.

The paper will occupy fully 60 pages in the Society's Transactions.

The Chairman in proposing that hearty and sincere thanks be given to Professor Mallet for his paper, said the suggestions he had made were most valuable, and it was to be hoped they would stimulate the younger chemists to carry out investigations such as he had referred to. He could not help feeling that Stas was more honoured among the English-speaking races than on the Continent. On the occasion of his lamented death, 12 months ago, the scientific societies of Belgium petitioned the Government to purchase his apparatus and some of his pure materials, and as many of his works could not be purchased, either because they were out of print or had been published in an inaccessible form, that funds should be voted for the publication of a complete set of Stas's memoirs and papers. After a considerable delay, the answer of the Government was to the effect that the schools were sufficiently supplied with apparatus and preparations. There was one memoir that Stas wrote that would be most valuable if it could be published, but he heard it was locked up in a Government Department. Stas was employed by the Government to investigate and determine the suitability of alloys of iron and other metals for the manufacture of heavy ordnance; his researches on the subject were most valuable, and he obtained some most important results: but hitherto all applications for permission to peruse his reports have been met with a refusal. If they could be made public, they would undoubtedly be of great value, both scientifically and practically.

Dr. Russell said that about 25 years ago, when working on the atomic weights of nickel and cobalt, he had the pleasure of seeing Stas in London, who took a very considerable interest in this work; at that time he had met with certain difficulties in purifying nickel: Stas took considerable interest in the matter, and wrote out for him a paper of instructions recommending him to follow a certain course, and, only a month or so ago, he happened to come across this.

Professor Dewar said that he was sure all must agree that one of the greatest services that could be rendered to the memory of Stas would be the complete publication of his memoirs. Resident as he had been in Belgium during a very interesting period of chemical history, he knew something of the support Stas gave to what, at the time, was a most revolutionary addition to chemical science. All present were aware that Kekulé was Professor in Ghent during many years, and the speaker was sure that he would be the first to acknowledge that it was largely owing to Stas's influence and assistance as an authority in Belgium, not only as a scientific man, but as a member of the highest social and political circles, that he was so splendidly supported by the Belgian Government. Furthermore, when the early memoirs of Körner, that are now classic, in which he suggested the position theory as an addition to the benzene or ring theory of Kekulé, were first submitted to the Belgian Academy, it was really Stas who secured their publication, and it was his encouragement of Körner's work that promoted the advent of the position theory in organic chemistry. To touch on the vast work of his life, and to attempt to criticise his researches, makes an ordinary observer feel exceedingly small. He always felt that, in comparison with modern work, a paper by Stas was an oasis of intellectual fruitfulness in a desert of arid vapid publication. We were all alike; we were all equally to blame; at home and abroad there was the same general tendency: the result being that our scientific literature is burdened by too many trivial, common-place productions, exhibiting no trace of any desire to cultivate originality or thoroughness. No chemist could read a paper by Stas without feeling himself an exceedingly small man. The noble inheritance left by Stas to chemists must live for ever, and it will always be a pleasure to any chemist wishing to cultivate his higher faculties, to read and study, and attempt to imitate his works.

Professor Dewar then referred to the determinations of the atomic weight of manganese and of the molecular weight of triethylamine, which he had carried out in conjunction with Dr. Scott (*cf. R. Soc. Proceedings*, 1883, 35, 44, 347). We were greatly indebted to Professor Mallet for the admirable *résumé* he had given, and for his friendly and critical remarks. He also, said Professor Dewar, was of opinion that the near approach in quite a number of the atomic weights to whole numbers is still a matter of very serious suggestive interest, and he proceeded to call attention to the results obtained on taking into account the values that the late Professor Dittmar found for the oxygen and hydrogen ratio, remarking that no man more competent to deal with this subject could be found, and that all must deeply deplore his loss while engaged in doing such splendid work on the very question under discussion. If we accepted Dittmar's number, which is corroborated by nearly half a dozen separate researches, 15·87, as expressing the ratio between the atomic mass of oxygen and the atomic mass of hydrogen, it appeared that the best-determined atomic weights fall into two totally different categories; some that apparently could not possibly be regarded as multiples of that of hydrogen approaching nearer, while others, seemingly very near to, are now far from being multiples of the atomic weight of hydrogen. Thus, silver, taking the Dittmar ratio, would come out very nearly a whole number, viz., 107·046. The most recent determinations of copper would give the value 63·09. Tin would be within 0·1 of a unit. In the same way, antimony would be within 0·1. Iodine, however, would be out. Zinc, also, would be decidedly out. Beryllium would be nearly a whole number. Bromine would be 0·26 out. There could be no doubt that in the case of gold, the number would be 195·61; while platinum would be 193·28, cerium 139·06, and boron 10·87, or near that. Professor Mallet made reference in his paper, he believed, to chlorine as an element which no one anticipated would come nearer a whole number than half a unit; but, as a matter of fact, chlorine now came within 0·2, viz., 35·16 of this element, and would fall into the class nearly approaching whole numbers. He noticed that Mallet had adopted the latest value of nitrogen. In his 1865 paper, the value 14·045 was given by Stas as the result of a very large number of determinations. Professor Dewar said he believed the number 14·055 was deduced entirely from experiments on the synthesis of nitrate of silver. Stas was so conscientious that he altered the value from 14·045 in his later paper in 1875, he believed, because the weight of nitrate of silver obtained by synthesis before fusion differed very slightly from the weight after fusion, and he thought that it was not fair to depend on the weight after fusion, because there might be a slight loss of nitric acid Consequently, in his later paper, he adopted 14·055, but that number is the result only of two determinations of the synthesis of nitrate of silver, whereas, in 1865, there were 10 or 12 different reactions from which the atomic weight of nitrogen was shown to be 14·045, not 14·055. This led him to remark that if we took the weight of ammonium as directly determined, which is probably as accurate a weight as any of Stas's numbers, viz., 18·076, and deducted 14·045 from it, the atomic weight of hydrogen relatively to 107·9 of silver or 16 of oxygen was 1·0077. That would give a ratio of the atomic weights of hydrogen to oxygen, transforming hydrogen to unity, of 1 to 15·88, so that Stas's determination of the weight of ammonium, deducting his own value for nitrogen, gives the ratio of the atomic weight of hydrogen to oxygen found by Dittmar, Rayleigh, and all the more recent investigators. He did not say this result is a coincidence; it must be due to the accuracy with which Stas determined the separate atomic weights. It was interesting to observe that the most recent density determinations gave both nitrogen and oxygen a little too high from the gravimetric point of view. Thus the determinations of Leduc make nitrogen and oxygen respectively 13·99 and 15·9 instead of 13·93 and 15·87; this was what we should expect if the oxygen, as we believe, be a little too dense, being nearer its critical point than hydrogen is, and the same applies to nitrogen. He could not help thinking the proposal made by Professor Mallet that the determination of atomic weights should be given to a Board would not turn out quite satisfactory in practice. But there were many points all would wish to clear up, and it would be a noble piece of work for some one to follow out Stas's own work, namely, to repeat any one of his fundamental syntheses. It would require a man of the type of Dittmar to do such work, however. Dittmar had, in fact, attempted the redetermination of one of Stas's values, and it was very important that we should have an explanation of the difference between the two workers. Dittmar had found in the case of lithium a number something like 6·86, whereas Stas's value was 7·02. Dittmar's method involved the analysis of lithium carbonate. He also determined the value of sodium by a similar method and obtained absolutely the same value as Stas for sodium. What was the explanation of such a remarkable difference in the value found by the Stas method? In the case of cadmium, also, there was apparently a difference of half a unit between some of the determinations. What was the reason of these differences? He referred to such cases as these two of lithium and cadmium, but there were others, and the problem was to find out how it is that methods nearly equally accurate, but differing essentially, give such discordant results, the work being carried out with the accuracy nowadays attainable. Finally, he was very glad to have had the opportunity of expressing his grateful thanks for the kindness of Stas in the past, and of bearing testimony to the great service he had done to science.

Dr. Scott referred to the work on which he was engaged in connection with Lord Rayleigh, with the object of determining the densities of oxygen and hydrogen, he having undertaken the determination of the volume ratios. Latterly, he had prepared hydrogen by passing steam into sodium, condensing it in palladium, and had obtained oxygen from oxide of silver; the experiments were made with successive fractions of the two gases driven off from the solid materials, which were kept in vacuous chambers sealed on to the gas analysis apparatus. He had now succeeded in obtaining the oxygen and hydrogen so pure that from the first fraction to the last he could detect no difference between them in the last series of determinations; whereas on using the hydrogen directly prepared from sodium and steam the ratio was 1 to 2·00243, that calculated on the whole of the hydrogen separated from the palladium was 2·00245. The last two figures he could hardly depend on.

Dr. Bailey thought that the extraordinary care taken by Stas in preparing and examining his materials, and in studying the changes made use of in his atomic weight determinations, served perhaps more than anything else to impress the student of his works. Referring to his own work, he mentioned having noticed that materials which are generally regarded as stable and non-volatile may be carried off by steam when their solutions are slowly boiled. Was it not conceivable that potassium chloride might thus be carried off in quantity sufficient to influence an atomic weight determination? He next spoke of the difficulty of obtaining concordant results in determining chlorine in the compounds of platinum metals. How this arose he was not able to say, but other workers had met with similar difficulties.

In closing the discussion, the Chairman expressed agreement with previous speakers that atomic weight determinations could not well be carried out by an organisation such as Professor Mallet had suggested.

December 15th, 1892. Dr. W. J. Russell, F.R.S., Vice-President, in the Chair.

Certificates were read for the first time in favour of Messrs. John Pedrozo d'Albuquerque, Barbadoes, W.I.; William James Cowan, 77, Trinity Road, Wood Green, London; George Davey, Las Trojes Angangues, Michoacan, Mexico; Daniel O. Sydney Davies, Rhydfallen, Stonebridge Park, Willesden, N.W.; Samuel Felix Dufton, D.Sc., Spring Wood House, New Cross Street, Bradford; John Henry Evans, 71, Lambton Road, Cottenham Park, Wimbledon; Charles Thomas Tyrer, Stirling Chemical Works, Stratford, E.; James Robert Thackrah, M.A., Technical Schools, Plymouth; John Cundell Wood, 3, Bedford Terrace, Sunderland.

The following were duly elected Fellows of the Society:—David Avery, Samuel Robert Adcock, William Smellie Anderson, Horace

Vincent Butterfield, Arthur John Bensusan, Arthur James Cooper, Frederick Walter Carlton, Ernest Victor Clark, Andrew Campbell, Andrew William Craig, Lionel Cooper, Joseph R. Denison, Thomas Duxbury, Martin Onslow Forster, William French, Walter Goodall, William Thomas Gronow, Thomas Gray, James G. Hardy, Walter S. Haines, Samuel C. Hooker, Ph.D., Edgar Edward C. Horwill, John Horsfall, Walter Holinshed Ince, Ph.D., John F. V. Isaac, Samuel Jackson, John Jackson, William George Johnston, G. Krause, Ph.D., Kunwar Kishor Kacker, Thomas Torrens Knowles, Charles Thornton Lamb, Francis Colin Moorwood, John Bate Nicholls, James Wyllie Rodger, Hugh Ramage, Norman Scott Rudolf, James Robson, Augustus Schloesser, Ph.D., Ernst Speidel, B.S., George Arthur Shaw, Reginald des Forges Shepherd, William James Sell, Satyaprasad Sarbadhicary, Charles Spackman, Albert Henry Turton, N. T. M. Wilsmore, William Williams, Jno. Lowe Whiteside, Jno. Williams, Frederick Henry Wigham, Frederick William Westaway.

Of the following papers those marked * were read:—

*82. "The identity of caffeine and theine and the interactions of caffeine and auric chloride." By Wyndham R. Dunstan and W. F. J. Shepheard.

Mays (*Journ. Physiol.*, **7**, 458; *Therapeutic Gazette*, 1866, 587) and more recently Lauder Brunton and Cash (*Roy. Soc. Proc.*, **42**, 238; *Journ. Physiol.*, **9**, 112) having concluded that "theine" from tea differs in its physiological action in certain respects from "caffeine" from coffee, the authors have deemed it desirable to compare the products from the two sources: they conclude that their identity is beyond question. The observed differences in physiological action must be ascribed either to impurities in the materials used, or to differences in the animals to which they were administered; the circumstance that "theine" has been found to be more active and to be capable of producing effects not produced by "caffeine" tends to support the view that the "theine" was impure, especially as it is known that tea contains other alkaloids.

It is found that when an aqueous solution of caffeine aurichloride is heated, a yellow, flocculent precipitate of *aurochlorocaffeine* is gradually formed, the $C_8H_{10}N_4O_2 \cdot HAuCl_4$ being resolved into 2HCl and $C_8H_9(AuCl_2)N_4O_2$; this substance is insoluble in alcohol, chloroform and ether, but dissolves in chlorhydric acid, being reconverted into the aurichloride; it is contended that the production of this compound is better shown by Medicus's formula of caffeine than by that proposed by Emil Fischer. A compound of caffeine and potassium aurichloride is described, crystallising in dark-red needles; it readily dissolves in alcohol and water, but apparently dissociates.

DISCUSSION.

Professor TILDEN, referring to his work on periodides of alkaloids published over 25 years ago (*C. S. Journ.*, **18**, 99; **19**, 145), said that he had not been able to notice any difference between the periodides prepared from caffeine and theine.

*83. "Studies on isomeric change. II. Orthoxylenesulphonic acids." By Gerald T. Moody, D.Sc.

The results described in this and the following note have been obtained in the course of an investigation on isomeric change now being carried on at the Central Institution (*cf.* these Proceedings, 1888, 77); the object in view was to determine whether 1 : 2 : 3-orthoxylenesulphonic acid is converted on heating into 1 : 2 : 4-orthoxylenesulphonic acid. In order to prepare the 1 : 2 : 3-acid, orthoxylene was first treated with two molecular proportions of bromine, whereby it was converted into a mixture of the liquid and solid dibromo-orthoxylenes; the latter (m. p. 88°)—which has been shown by Jacobsen to have the constitution $2CH_3 : 2Br = 1 : 2 : 4 : 5$ —was sulphonated by very cautiously heating it in a water-bath with about 10 times its weight of 15 per cent. anhydrosulphuric acid until the mixture became liquid, then keeping it at 75°, with constant shaking, until complete dissolution of the oil was effected; the liquid solidified on cooling. The resulting sulphonic acid was converted first into barium salt and eventually into sodium salt. *Sodium dibromorthoxylenesulphonate*, $C_6HBr_2(CH_3)_2SO_3Na + 1\frac{1}{2}H_2O$, crystallises in small scales, and is easily reduced on boiling it with zinc-dust and sodium hydroxide, forming 1 : 2 : 3-sodium orthoxylenesulphonate. The latter crystallises in beautiful, long, flat, monohydrated plates; unlike the sodium salt of the 1 : 2 : 4-acid, it does not effloresce in air. 1 : 2 : 3-Orthoxylenesulphonic chloride crystallises from light petroleum in prisms melting at 47°, the sulphonamide crystallising from water in groups of needles melting at 167°.

The 1 : 2 : 3-sulphonic chloride was converted into the acid by heating 5 grams of it with 20 c.c. of water in a sealed tube immersed in the vapour from boiling xylene, the tube being, from time to time, removed from the bath and shaken; the resulting solution was cautiously evaporated on a steam-bath. The crystalline acid thus formed remained dry on being exposed to the air for several days; a small portion was converted into sulphonamide, which melted sharply at 167°, showing it to be the unchanged 1 : 2 : 3-acid; the rest was placed in a tube standing in an oil-bath heated at 115—120°, and a current of dry air drawn over it during two hours, at the end of which time the acid had become dark grey in colour. The sulphonamide prepared from the thus-heated acid melted sharply at 144°, showing that the 1 : 2 : 3-acid had been completely converted into the isomeric 1 : 2 : 4-acid. On repeating the experiment, the same result was obtained ; and it is worthy of remark that in both cases only a very slight indication of the formation of sulphuric acid was obtained.

*84. "Studies on isomeric change. III. Phenetoilsulphonic acids, $C_6H_4(OEt)SO_3H$." By Gerald T. Moody, D.Sc.

In a note published early in the year (these Proceedings, 1892, 90) the author stated that only one sulphonic acid is formed by the interaction of sulphuric acid and phenetoil under ordinary conditions ; Lagai not long afterwards controverted this statement (*Ber.*, 1892, 1839) and asserted that he had isolated a second acid from the product of sulphonation : describing its chloride as a syrupy liquid, and its amide as crystallising from water in feathery needles melting at 142°. Lagai however, quoted no analyses, or other evidence to show that his compound melting at 142° was really a derivative of phenetoil.

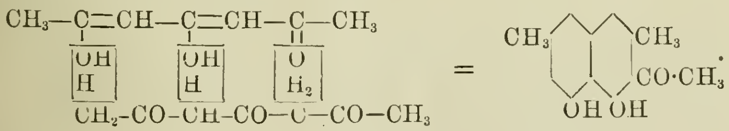
In order to obtain orthophenetoilsulphonic acid, parabromophenol was ethylated. The bromophenetoil thus formed boiled constantly at 228—230°, and readily sulphonated when shaken with an equal bulk of ordinary oil of vitriol. The resulting bromophenetoilsulphonic acid crystallised from the acid solution in characteristic prisms. It was readily reduced by digestion with zinc-dust and sodium hydroxide solution. The sodium salt of the resulting ortho-acid, $C_6H_4(OEt)SO_3Na + H_2O$, crystallised in slender needles ; it afforded a sulphonic chloride which crystallised from light petroleum in thin plates melting at 62°, from which a sulphonamide was obtained, crystallising in very long, flexible needles, melting at 156°. These melting points place beyond doubt the fact that Lagai's compound melting at 142° is not phenetoilorthosulphonamide. On the other hand, the sulphonic acid giving a chloride and amide melting at 62° and 156°, respectively, is shown to be a phenetoil derivative by its behaviour on heating. The pure acid was formed by digesting the sulphonic chloride melting at 62° with dilute alcohol for 12 hours, and then evaporating the solution ; it was obtained as a crystalline mass, permanent in air. A small quantity of this product was converted into sulphonamide, which was found to melt at 156° ; the remainder was placed in a tube contained in an oil bath and heated for three hours at 100°, a current of dry air being passed through the tube ; during the process, the acid darkened somewhat in colour, and was eventually found to contain a minute quantity of sulphuric acid. The acid thus heated gave a sulphonamide which melted sharply at 150°, showing that a complete change to the para-acid had taken place.

*85. "Formation and nitration of phenyldiazoimide." By William A. Tilden and J. H. Millar.

Phenyldiazoimide, $N_3 \cdot C_6H_5$, is readily prepared by the interaction of nitrosyl chloride and phenylhydrazine dissolved in excess of glacial acetic acid, together with only a small quantity of resinous bye-products. When gently heated with ordinary strong nitric acid, the imide yields about two-thirds of its weight of the paranitro-derivative (m. p. 74°), together with smaller quantities of two crystalline bye-products not yet fully examined. Nitrophenyldiazoimide forms a convenient source from which to obtain Curtius' diazoimide, about 40 per cent. of the calculated quantity of the compound being obtained, as shown by Noelting, Grandmougin and Michel (*Ber.*, **25**, 3328), on boiling it with alcoholic potash.

*86. "The production of naphthalene derivatives from dehydracetic acid." By J. N. Collie.

The author has further examined the yellow substance referred to in his previous notice (these Proceedings, 1892, p. 188), and arrives at the conclusion that the condensation of diacetylacetone probably occurs in the following manner:—



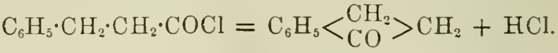
At first he was inclined to the belief that the substance was a quinone, but, as all attempts to reduce it failed, and as it did not, in other respects, behave as a quinone, he has abandoned the idea; moreover, it is impossible to explain the formation of a quinone from diacetylacetone by any simple interaction such as the mere elimination of the elements of water involves.

The substance yields a diacetyl derivative when heated with acetic anhydride, and affords bromine substitution derivatives when treated with bromine. A trimethylnaphthalene is produced on distilling the diacetate with zinc-dust.

Finally, it is pointed out that the 2-aceto-1-naphthol described by Witt (*Ber.*, **21**, 321) and the 3-aceto-1-naphthol prepared by Erdmann (*ibid.*, p. 635) closely resemble the compound from diacetylacetone.

87. "A new synthesis of hydrindone." By F. Stanley Kipping, Ph.D., D.Sc.

In a previous note (these Proceedings, **112**, 107) it has been stated that a hydrocarbon of the composition C_3H_2 and other compounds are produced by the action of phosphoric anhydride on phenylpropionic acid; as the whole behaviour of the hydrocarbon pointed to its having a high molecular weight, it seemed probable that its formation was brought about by the condensation of two or more molecules of some intermediate product, possibly hydrindone. As this assumption could only be satisfactorily settled by preparing the hydrocarbon from hydrindone, attempts were made to synthesise the latter by treating phenylpropionic chloride with aluminium chloride; a few trials had already been made, with but slight success, when the writer's attention was called to a note by Hughes (these Proceedings, **96**, 70), in which similar experiments with phenylpropionic chloride, carried out at Marsh's suggestion, were described; on continuing the experiments, it was soon found that, although Hughes failed to obtain hydrindone, it can be easily prepared in large quantities by the method suggested, and that, under suitable conditions, the yield of pure compound is 50—60 per cent. of the theoretical, its formation being expressed by the equation



$$C_6H_5{\cdot}CH_2{\cdot}CH_2{\cdot}COCl = C_6H_5{<}\genfrac{}{}{0pt}{}{CH_2}{CO}{>}CH_2 + HCl.$$

The ketone prepared in this way crystallises in colourless, waxy plates melting at 41—42°, and is identical with the hydrindone obtained by Gabriel and Hausmann (*Ber.*, **22**, 2019) from ethylic orthocyanobenzylacetate, and by König (*Inaug. Diss.*, *Leipzig*, 1889) from orthocarboxyhydrocinnamic acid.

Several derivatives of hydrindone have been prepared and characterised:—The hydrazone, $C_{15}H_{14}N_2$, crystallises from dilute alcohol in almost colourless needles melting at 127—128°. The *hydroxime*, $C_9H_8{:}NOH$, crystallises from benzene in colourless needles melting at 140—141°. The *nitro*-derivative, $C_9H_7O{\cdot}NO_2$, is a colourless, crystalline substance melting at 75—76°.

When heated with moderately concentrated sulphuric acid, hydrindone yields a compound of the composition $C_{18}H_{14}O$; this condensation product crystallises from dilute alcohol in yellowish plates melting at 141·5—142·5°. When warmed with phosphoric anhydride, hydrindone is converted into a yellowish, crystalline substance, which, judging from its general behaviour, is identical with the hydrocarbon obtained by treating phenylpropionic acid with phosphoric anhydride.

The investigation is being continued in other directions, as it appears probable that similar intramolecular condensations may be brought about in the case of other benzenoid compounds containing a side chain with the aid of aluminium chloride.

88. "The resolution of methoxysuccinic acid into its optically active components." By T. Purdie, Ph.D., B.Sc., and W. Marshall, B.Sc.

The authors find that inactive methoxysuccinic acid—prepared from fumaric acid by the addition of the elements of methylic alcohol—can be resolved into optically active components by means of the acid cinchonine salt, the salt of the dextrogyrate acid being less soluble in water and crystallising more readily than the corresponding salt of the lævogyrate acid. The separation of the active acids effected in this manner, however, was only partial, the metallic salts obtained after removal of the cinchonine being mixtures of active with more or less inactive salt, from which the latter had to be separated by fractional precipitation or crystallisation.

In a first series of experiments the elimination of the inactive salt was effected by means of the different solubilities of the calcium and hydrogen potassium salts, the salts of the active acids being more soluble than those of the inactive acid. When solutions containing equal quantities of the oppositely active hydrogen potassium salts were mixed, the inactive salt was instantaneously precipitated.

The specific rotatory power of the active acids in a 5 to 10 per cent. aqueous solution is about 33°; they melt at 88—90°, the inactive acid melting at 108°. The specific rotatory power of the normal ammonium and potassium salts is of the same sign as that of the acids, but not so great, and it does not vary much with change of concentration; that of the calcium and barium salts is of opposite sign to that of the acid, and diminishes rapidly with decreasing concentration, the sign of the rotation of the latter salt being reversed in very dilute solutions.

89. "Optically active ethoxysuccinic acid." By T. Purdie, Ph.D. B.Sc., and I. Wallace Walker, M.A.

When spores of *Penicillium glaucum* are sown in a solution of the inactive acid ammonium salt of the inactive ethoxysuccinic acid formed by the addition of the elements of ethylic alcohol to fumaric acid, to which nutritive mineral salts have been added, an abundant growth of mycelium ensues, the result being that the lævogyrate component of the inactive acid is consumed, the dextrogyrate being left unaltered. The specific rotatory power of the acid in a 5 to 10 per cent. solution is about +33°; it melts at 76—80°, while the inactive acid melts at 86°.

The active acid ammonium salt crystallises with one molecular proportion, the corresponding inactive salt with half a molecular proportion, of water.

The inactive acid can also be resolved into its active components by means of the cinchonidine salt, the salt of the dextrethoxysuccinic acid being less soluble in water than its oppositely active isomeride. The active components were not obtained in the pure state by this process, but oppositely active acid ammonium salts were obtained which crystallise exactly like the salt produced by means of *Penicillium*, and whose specific rotations approximated in amount to that of the latter.

The authors find a close parallelism in respect of optical activity between the dextromethoxysuccinates, and dextrethoxysuccinates, the remarks about the former in the preceding abstract applying in general to the latter. The ethoxysuccinates are, however, more dextrorotatory or less lævorotatory than the corresponding methoxysuccinates.

The bearing of some of these observations on the theories advanced by P. A. Guye (*Annalen* [6], **25**, 145) and by Crum Brown (*Proc. R. S. E.*, **17**, 181) regarding the relations of optical activity to the nature of the radicles which are united to the asymmetric carbon atom is discussed.

90. "The formation of benzyldihydroxypyridine from benzylglutaconic acid." By S. Ruhemann, Ph.D., M.A.

Ethylic benzylglutaconate (*cf. Annalen*, **222**, 261) slowly dissolves in a concentrated aqueous solution of ammonia at 100°, forming a coloured liquid, from which acids precipitate benzyldihydroxypyridine —a substance which exhibits both acid and basic properties. It crystallises in glittering plates which melt at 184°; its dibenzoate melts at 164°. On oxidation, it readily yields coloured products possessed of tinctorial powers.

91. "The action of nitrous acid on 1-α-amido-2-β-naphthol: a correction." By R. Meldola, F.R.S.

In a paper published conjointly with G. T. Morgan (Trans., **55**, 114), wherein we had occasion to identify α-amido-β-naphthol in the presence of other bases, we stated that the yellow crystalline substance obtained by the action of nitrous acid was nitroso-β-naphthol.

At the beginning of the present year a paper by Grandmougin and Michel appeared (*Ber.*, **25**, 972), in which these authors stated that the compound in question was β-naphthaquinone. I repeated the experiment at the time, and confirmed their statement. They have called attention to the discrepancy in another paper just to hand *Ber.*, **25**. 3429), and ask for further details. In reply, I have only to state that I was not particularly concerned at the time with the nature of the crystalline compound, and it was not very closely investigated, as will be seen on reference to our paper (*loc. cit.*, p. 120). The superficial examination of the substance which we made led us to the belief that it was nitroso-β-naphthol, as it had a similar melting point, and was soluble in alkali, and the subject was not further pursued, as it was beyond the scope of our investigation. The subsequent investigations by Grandmougin and Michel have convinced me that the substance which we had in hand was impure β-naphthaquinone, possibly mixed with some β-naphthaquinoneanilide, owing to the retention of a trace of aniline salt. The formation of β-naphthaquinone by the action of nitrous acid on α-amido-β-naphthol is a most unexpected discovery, which could not possibly have been foreseen, and the credit of which is entirely due to these authors. I have frequently had occasion to repeat this test in the course of some recent investigations of which the results will be communicated to the Society subsequently: the method described by Grandmougin and Michel is certainly the simplest and by far the most effective yet made known for preparing pure β-naphthaquinone in large quantities.

92. "Note on the action of phenylhydrazine on mono- and dicarboxylic acids at elevated temperatures." By W. R. Hodgkinson and A. H. Coote.

Phenylacetic acid and phenylhydrazine readily interact when heated together at 120°, forming $C_6H_5{\cdot}N_2H_2{\cdot}CO{\cdot}CH_2{\cdot}C_6H_5$ (Bülow, *Annalen*, **236**, 196). In preparing this and similar hydrazides for another investigation, it was observed that a certain amount of decomposition took place, ammonia being one of the products. The course of the decomposition in the case of several monobasic benzenoid acids was, therefore, studied.

When heated with an equivalent quantity of phenylhydrazine phenylacetic acid at first gives off water at temperatures up to 150°, the action then becomes more energetic, nitrogen and ammonia being evolved, light oils distilling over; and as the temperature is raised, between 280° and 350°, a thicker oil distils over, a slight tarry residue being left in the retort. The lighter oils were found to consist of benzene and aniline. The greater portion of the heavy oil boiled between 320° and 370° C. On fractionating, a heavy substance was obtained, boiling at about 340°, free from nitrogen, which on analysis gave figures corresponding to the formula $C_{14}H_{12}O_2 = C_6H_5{\cdot}CH_2{\cdot}CO{\cdot}C_6H_5$, viz., 85·8 per cent. carbon and 6·22 per cent. hydrogen, the theoretical values being 86·0 and 6·12.

The decomposition cannot be very directly formulated. The first stage is the formation of the hydrazide, $C_6H_5{\cdot}CH_2{\cdot}CO{\cdot}NH{\cdot}NH{\cdot}C_6H_5$; but on heating this, NH·NH is split off, which immediately breaks up and reduces neighbouring molecules of phenylhydrazine partly to aniline and partly to benzene, with liberation of nitrogen and ammonia.

In the case of orthotoluic acid, $C_6H_4{\cdot}CH_3{\cdot}COOH$, a similar action takes place, but the amount of high boiling oil (ketone) is somewhat less, and the amounts of benzene and aniline somewhat greater.

In the case of phenylpropionic acid action also takes place in a manner analogous to that observed in the case of phenylacetic acid.

Some dibasic acids, for example, succinic acid, exhibit a behaviour similar to that described when heated with phenylhydrazine, ammonia and nitrogen escaping, while a high boiling oil, free from nitrogen, distils over.

The authors desire to reserve the further study of these interactions for a short time.

RESEARCH FUND.

A meeting of the Committee will be held in January. Fellows desiring grants are requested to make application to the Secretaries before January 14th.

KOPP MEMORIAL LECTURE.

An extra meeting of the Society will be held on February 20th, 1893, at 8 P.M., the anniversary of the death of Hermann Kopp, when a lecture will be delivered by Professor Thorpe, F.R.S.

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Nov. 6, 1876	Trans	Auerbach, G., Breite Strasse 7, Ludwigshafen a/Rh. Germany

Date of Election.		
Feb. 17, 1877		Austen, Peter Townsend, Chemical Laboratory, Rutgers College, New Brunswick, N.J., America
Feb. 19, 1891		Aylan, John Charles, Manager Royal Laboratory, Royal Arsenal, Woolwich, S.E.
Mar. 6, 1890		Babington, Percival, A.I.C., 6, Grange-terrace, Weymouth
Dec. 16, 1875	Trans.	Bailey, G. H., Ph.D., D.Sc., Owens College, Manchester
April 4, 1889		Bailey, Richard Douglas, City Brewery, Quay-street, Gloucester
Feb. 21, 1884		‖Bain, Daniel, Laboratory, Newcastle Chemical Company, Gateshead
Dec. 3, 1891		Bairstow, John, 32, Sealand-road, Chester
Dec. 5, 1889		‖Baker, Charles Frederic, Ph.D., The Yorkshire College, Leeds
Dec. 6, 1883	Trans.	Baker, Charles J., The Schools, Shrewsbury.
Feb. 17, 1881	Trans.	Baker, Harry, The Alluminium Co., Oldbury, near Birmingham
June 19, 1884	Trans.	‖Baker, H. Brereton, Dulwich College, S.E.
May 1, 1873		Baldock, John Henry, Overdale, St. Leonard's-road, Croydon, Surrey
May 20, 1886	Trans.	Ball, Edwin Jennings, Ph.D., Metallurgical Laboratory, Royal College of Science, South Kensington
June 16, 1892		Ballantyne, Horatio, 260, Renfrew-street, Glasgow
Dec. 18, 1884		Ballard, J. Farrow, Cornwall House, Maidenhead
Dec. 3, 1891		Baly, Edward C. Cyril, Bank of England, E.C.
Mar. 4, 1886		Bamber, Henry K., Cement Works, Dovercourt, Essex
Dec. 4, 1890		Bamber, M. Kelway, Agricultural and Horticultural Society of India, Metcalfe Hall, Calcutta
Feb. 2, 1888		Banner, Samuel, Sherwood, Sefton-park, Liverpool
Jan. 19, 1871		Bannister, Richard, Inland Revenue Laboratory, Somerset House, W.C.
Feb. 16, 1888		Barbour, T. Fraser, 35, Robertson-street, Glasgow
Dec. 2, 1880		Barclay, Arthur E., 95, Farringdon-street, E.C.
June 16, 1887		Barclay, Hugh, Calder Avenue, near Coattridge, N.B.
Dec. 1, 1870		Barklie, Robert, Knockmhore, Greenisland, Belfast
June 19, 1884		Barlow, Edward G. B., 27, West-hill, St. Leonard's-on-Sea, Sussex
Jan. 17, 1889		Barnes, Charles Lightfoot, 10, Nelson-street, C. on M., Manchester
May 7, 1891		Barnes, Edward Arthur, Upton Villa, Dynamite Works, Hayle, Cornwall
Dec. 2, 1875		‖Barnes, R. L., Oak Hall, Buckhurst-hill
Feb. 21, 1884		Barr, William Henry, M.D., Belgrave-place, Bury
Feb. 16, 1888		Barraclough, William H., A.I.C., Pembroke House, Atherton-road, Forest Gate, E.
Dec. 3, 1891		Barratt, J. Treeby, Bronhenlog, Mostyn, North Wales
May 5, 1892		Barratt, Alexander, Bronhenlog, Mostyn, North Wales

Date of Election.		
Feb. 4, 1869		Barret, Edward L., B.Sc., 192, Belsize-road, Hampstead, N.W.
Feb. 5, 1874		Barrett, Howard, M.R.C.S., M.R.C.P., 3, Tavistock-square, W.C.
April 4, 1889		Barry, T. D. Collis, M.R.C.S., Staff Surgeon, Asirgarh, Central India Province, India
Jan. 18, 1872		Barton, Robert, Royal Mint, Melbourne, Australia, and c/o Miss Barton, The Cottage, Bushey Park, Teddington
April 19, 1883		Basker, J. A., Fore street, Bridgwater
Feb. 18, 1864	Trans.	‖Bassett, Henry, 26, Belitha-villas, Barnsbury, N.
May 7, 1891		Bate, William, National Explosives Co., Hayle, Cornwall
May 7, 1891		Bater, Claude H., M.A., Inland Revenue Laboratory, Ashwell, near Hitchin, Herts
April 17, 1884		Battershall, J. B., Ph.D., United States Laboratory, 402, Washington-street, New York
June 16, 1892		‖Barrows, Arthur Edward, Bloomfield Iron Works, Tipton Staffordshire
June 16, 1892		Bayliss, Charles, Selly Park, near Birmingham
Nov. 19, 1874		Bayly, F. W., The Royal Mint, E.
June 4, 1874		‖Bayne James, Professor Royal Veterinary College, Camden Town, N.W.
June 19, 1879		‖Bayne, William Thirlwall, LL.D., Brockhill, Broad Clyst, Exeter
Dec. 4, 1873		Baynes, James, jun., Ph.D., F.R.M.S., Borough Analyst's Office, Royal Chambers, Scale-lane, Hull
Feb. 19, 1891		Beadle, Clayton, Beadonwell, Belvidere, Kent
Feb. 7, 1861		‖Beadnell, Major Charles Edward, R.A., 48, Castletown-road, W. Kensington
Dec. 5, 1867		Beale, William Phipson, 10, New-court, Carey street, Lincoln's-inn, W.C.; and 19, Upper Phillimore gardens, Kensington, W.
Mar. 3, 1864		‖Beanes, Edward, Moatlands, Paddock-wood, Kent
Mar. 6, 1890		Beardmore, G. Russell, D.P.H. Camb., L.R.C.P. Lond., M.R.C.S. Eng., L.S.A., Warwick House, Upper-street, Islington, N.
April 21, 1887		Beasley, William C. T., B.A., Fermain, St. Leonards on-Sea
Dec. 1, 1864		‖Beauchamp, Lieut. C. S., Brompton Barracks, Chatham
April 17, 1890		Beck, Charles R., 6, White Ladies'-road, Clifton, Bristol
April 2, 1874	Trans.	Beckett, George Henry, care of Alfred Nobel Chemisches Laboratorium, San Remo, Italy
May 4, 1882		Beckett, John Hampden, Corbar Hill House, Buxton, Derbyshire
Feb. 6, 1879	Trans.	Bedson, P. Phillips, D.Sc., University of Durham, College of Physical Science, Newcastle-on-Tyne
Nov. 17, 1851	Trans.	Beesley, Thomas, 31, West Bar-street, Banbury
Dec. 19, 1872	Trans.	‖Beilby, George T., St. Kitts, Slateford, N.B.
June 18, 1891		Belbin, T. St. John, 12, Bolton gardens West, South Kensington
Dec. 6, 1888		Belcher, John Hope, B.A., Science School, Lincoln
May 7, 1891		Bell, Albert Edward, Hound-street, Sherborne, Dorset

Date of Election.		
Dec. 2, 1886	Trans.	Bell, Chichester A., B.A., M.B., Unity. Dublin, 3, Mansfield-place, Richmond, Surrey
June 20, 1889		Bell, E. Wightman, Spalding
June 21, 1877	Trans.	Bell, H. Stowe, 2, St. Anne's-park-villas, Wandsworth, S.W.
Jan. 20, 1870		Bell, James, D.Sc., C.B., F.R.S., Laboratory, Somerset House, W.C.
Jan. 19, 1865	Trans.	‖Bell, J. Carter, A.R.S.M., F.I.C., The Cliff, Higher Broughton, Manchester
Dec. 3, 1863		Bell, Sir Lowthian, Bart., F.R.S., Rounton Grange, Northallerton
Jan. 17, 1889		‖Bell, Percy Carter, The Cliff, Higher Broughton, Manchester
Nov. 19, 1885		Bell, W. J., Sir, LL.D. (Cantab), F.R.S. Edin., Scatwell, Muir of Ord, N.B. and Reform Club, S.W.
Dec. 4, 1879		Bemrose, Joseph, 158 Box, P.O., Montreal, Canada
Dec. 17, 1874		‖Bendix, David, 216A, Romford-road, Stratford, E.
Nov. 19, 1874		Benger, Frederick Baden, F.I.C., The Grange, Knutsford, Cheshire
Feb. 17, 1881		‖Benjamin, Marcus, A.M., Ph.D., care of D. Appleton and Co., 1, Bond-street, New York
April 15, 1836		Bennert, Carl, Ph.D., Godesberg, Germany
Dec. 4, 1890		Bentz, Ernest, 147, Bishop-street, Alexandra Park, Manchester
June 21, 1883		‖Beringer, Cornelius, F.I.C., 9, West-end, Redruth
Feb. 16, 1882		‖Beringer, John J., Basset-road, Camborne, Cornwall
Mar. 6, 1890		Berncastel, Richard, 7, Woodvale, Forest-hill, London, S.E.
June 17, 1875		Bernstein, Ludwik, M.D., F.R.S.E., Lismore, New South Wales
Feb. 16, 1888		Berridge, Henry Dudley, M.A., Fotheringhay, Oundle, Northamptonshire
Dec. 7, 1882		‖Berry, Edward E., Villa Rosa, Bordigherd, Italy
Dec. 3, 1891		Berry, Thomas William, Granville terrace, Stone, Staffordshire
Dec. 6, 1888		Berry, William, 7, Hampton-park, Redland, Bristol
Dec. 15, 1892		Bersusan, Arthur J., 13, Lansdowne-road, Kensington-park, W.
Mar. 1, 1883	Trans.	Bevan, Edward J., 4, New-court, Lincoln's-inn, W.C.
Dec. 2, 1886		Bevan, John William, care of Sir James Murray and Co., Chemical Works, Temple street, Dublin
Dec. 7, 1865		‖Bickerdike, W. E., Clayton Grange, Wilpshire, near Blackburn
May 4, 1882		Bicket, John Hugh, Laboratory, London Hospital, Mile End-road, E.
Feb. 18, 1875		Biggart, J. W., Chemical Laboratory, 29, Cathcart-st., Greenock
Mar. 7, 1872		Biggs, C. H. W., 140, Salisbury-court, Fleet-street, E.C., and Broomfield, Bromley, Kent
Mar. 16, 1882		Billing, Henry S., c/o Burnard & Alger, Ld., Plymouth
Dec. 15, 1881		Bingley, John, Northampton
June 4, 1874		Bird, Henry, 95, Durnford-street, Stonehouse, Plymouth
May 20, 1875	Trans.	Bischof, Gustav, Prof., 16, Colville-square, Bayswater, W., and 4, Hart-street, Bloomsbury

Date of Election.		
April 1, 1880		Black, A. Elliot, 5, Hillsborough-square, Bruce street, Hillhead, Glasgow
April 17, 1879		Black, A. H., F.R.G.S., St. John's, Wakefield
Dec. 2, 1886		Blackett, Cuthbert R., Prof., Laboratory, Swanston-street, Old County Court, Melbourne
Dec. 18, 1879		Blackburn, Thomas, Aruba Phosphaat Maatschappy, Curaçoa, West Indies
March 5, 1885		Blades, Chas. Mountain, Bay Villa, Chester-road, Northwich, Cheshire
Dec. 6, 1883		Blair, Frank A., Broomfield, Melrose, N.B.
June 17, 1886		Blake, James, M.D., F.R.C.S., Middleton Lake Co., California, U.S.A.
Mar. 6, 1890		Blake, Robert R. F., Chemical Department, Queen's College, Belfast
May 15, 1890		Blake, William Henry, 31, Norfolk-street, Sunderland
June 3, 1875		‖Blanshard, Charles Thomas, M.A., Cheltenham House, Epsom
June 16, 1892		Bleckly, Arthur Sanderson, Thelwall Lea, near Warrington
Dec. 4, 1890		Blenkinsop, W. E. B., 15, Earlsfield-road, Wandsworth Common, S.W.
Feb. 19, 1891		Bloomer, Frederick John, F.I.C., Sunnyside, Byrne-road, Balham, S.W.
Mar. 6, 1890		Blount, Bertram, Laboratory, Broadway, Westminster, S.W.
Feb. 2, 1888		Bloxam, Arthur G., F.I.C., The Goldsmiths' Institute, New Cross, S.E.
Dec. 20, 1883	Trans.	Bloxam, W. Popplewell, B.Sc. Lond., F.I.C., Royal Naval College, Greenwich, S.E.
Feb. 2, 1865	Trans.	Blunt, T. P., M.A., Tower-place, Shrewsbury
April 21, 1887		Blundstone, Edwin Richardson, B.A., Cornwall Lodge, Hampton Hill, Middlesex
June 3, 1875	Trans.	Blyth, Alexander Wynter, M.R.C.S., 17, Marlborough Hill, N.W.
May 5, 1892		Blyth, Frederic William George, Clifton Wood Villa, Clifton, Bristol
Dec. 2, 1875		‖Boake, A., Stratford, London, E.
April 4, 1889		Boam, Frederick William, The Chemical Laboratory, Royal Arcade, Leicester
Mar. 1, 1883		‖Board, Gregory, c/o Whitham Cross, Secretary Colorado Scientific Society, Box 2658, Denver, Colorado
Feb. 7, 1878		Bodmer, Richard, 8, Grosvenor gardens, Muswell-hill, N.
Dec. 6, 1888		Bohm, William Dunsmore, A.R.S.M., F.I.C., 51, The Avenue, Acton, W.
Mar. 18, 1869	Trans.	‖Bolas, Thomas, Turnham-green, W.
Feb. 18, 1892		Bond, Frederick Fielding, M.D, Rosemary House, Rastrick, Yorks
June 17, 1858		Bond, F. T., M.D., Gloucester

Date of Election.		
Feb. 1, 1883		Bond, Henry C., M.A., Bromley Park School, Bromley, Kent
Mar. 1, 1877		Borland, John, F.L.S., Etruria, Kilmarnock
April 17, 1884		Borland, W. D., Beacon Lodge, Green street, Green, near Dartford, Kent
Mar. 17, 1881		‖Borns, Henry, Ph.D., 19, Alexandra-road, Wimbledon, S.W.
Feb. 2, 1861		‖Bosanquet, R. H. M., F.R.S., New University Club, St. James'-street, S.W.
June 16, 1881		Bostock, G. H., Avenue-road, Doncaster
Dec. 15, 1881	Trans.	Bothamley, Charles H., F.I.C., Taunton, Somerset
June 16, 1887	Trans.	Bott, William, Ph.D., Raffles Institution, Singapore
Mar. 6, 1873		Bottle, Alexander, 4, Godwyn-road, Dover
June 15, 1871		Bottomley, James, B.A., D.Sc., Homer-terrace, Lower Broughton, Manchester
May 15, 1869		Bottomley, James T., M.A., F.R.S., F.R.S.E., 13, University Gardens, Glasgow
Dec. 2, 1886		Bottomley, W. Beecroft, Ph.D., Fern Cliffe, Morecambe, near Lancaster
Dec. 3, 1891		Bovell, John R., Dodd's Botanical and Experimental Station, Barbados
April 20, 1865		‖Bowdler, A. C., 20, Wellington street, Blackburn
Dec. 6, 1888		Bower, Frank, 37, Lansdowne-road, South Lambeth-road, S.W.
June 21, 1883		Bowler, G. S., 24, Kent House-road, Sydenham, S.E.
Nov. 6, 1862		Bowman, Frederick H., D.Sc., F.R.A.S., F.L.S., F.G.S., F.S.A., F.R.M.S., West Mount, Halifax, Yorkshire
Dec. 16, 1869	Trans.	Bowrey. J. J., Kingston, Jamaica
April 15, 1869		‖Braby, Frederic, Bushey Lodge, Teddington
June 21, 1888		Bradshaw, Charles, 10, The Nook, Barber-road, Sheffield
Mar. 2, 1876		‖Bradley, N., 51, Chapman-street, Hulme, Manchester
Mar. 17, 1881		Braga, J. F., L.S.A., F.R.G.S., Glen Villa, Halliford-road, Sunbury-on-Thames
Dec. 5, 1872	Trans.	Braham, Philip, 6, George-street, Bath
Nov. 20, 1890		Branson, Charles F., Frankfort House, West-side, Clapham Common, S.W.
Dec. 7, 1882		Branson, F. W., 14, Commercial-street, Leeds
June 15, 1882	Trans.	Brauner, B., Ph.D., University of Prague, Bohemia, and Brenute Gasse, 4, Prague, Bohemia
Dec. 6, 1883		Briant, Lawrence, 24, Holborn-viaduct, E.C.
Dec. 4, 1890		Brierley, John Thomas, 249, Bolton-road, Chorley, Lancashire
April 19, 1883		Briggs, T. Lynton, 357, Madison-street, Brooklyn, New York, U.S.A.
Dec. 18, 1884		‖Briggs, William, Burlington House, Cambridge
Feb. 6, 1890		Brindley, George F., Aluminium Company, Oldbury, near Birmingham
April 4, 1889		Broadbent, Harry, A.I.C., 125, Belle Vue-road, Leeds

Date of Election.		
Feb. 6, 1879		Broadbent, John J., Ellesmere House, Patricroft, near Manchester
Feb. 1, 1883		Brock, John, J.P., Wellfield, Farnworth, Widnes, Lancashire
Dec. 18, 1884		Brodie, Sir Benjamin V. S., Bart., Brockham Warren, Betchworth
Dec. 16, 1886		Brothers, Horace Edward, Zaffre Cottage, Golden Hill, Stoke-on-Trent
Jan. 17, 1884		Brough, Bennett Hooper, Assoc. R.S.M., F.I.C., F.G.S. 5, Robert-street, Adelphi, W.C.
Nov. 20, 1884		Broughton, Frank, University of London, Burlington-gardens, W.
May 4, 1876	Trans.	Brown, Adrian John, 54, Spring Terrace-road, Stapenhill, Burton on-Trent
Dec. 5, 1867	Trans.	Brown, Dr. A. Crum, F.R S., 8, Belgrave-crescent, Edinburgh
Mar. 17, 1870		Brown, David, 93, Abbey-hill, Edinburgh
June 18, 1891		Brown, Edward, 32, Courlandsky-street, St. Petersburg, and care of Wm. Brown, Heaton-street, Cleckheaton
Mar. 20, 1873	Trans.	‖Brown, Frederic Douglas, Prof., B.Sc., Univ. Col., Auckland, New Zealand
Mar. 20, 1884		Brown, Frederick William, Ingleside, Lambourne, Warminster, Wilts
May 5, 1892		Brown, George Fitz, The Broughton Copper Company, Ditton Copper Works, Widnes
June 17, 1880		Brown, Henry, Cannon Brewery, Watford, Herts
Jan. 19, 1871	Trans.	Brown, H. T., F.R.S., 47, High-street, Burton on-Trent
Mar. 7, 1867	Trans.	‖Brown, James Campbell, D.Sc., University College, Liverpool
April 19, 1866	Trans	Brown, James T., 28, Anhalt-road, Albert Bridge-road, S.W.
Mar. 16, 1881		Brown, Joseph, 3, Plevna-terrace, Savile Town, Dewsbury
May 5, 1882		Brown, Reginald B., Ellerslie, Knighton Park-road, Leicester
Feb. 19, 1891		Brown, Robert John, The Technical School, Stockport
Dec. 18, 1884		Brown, William George, Ph.D., Washington, and Lee University, Lexington, Virginia, U.S.A.
Feb. 20, 1873		Brownen, George, 16, Althorpe-road, Upper Tooting, S.W.
Dec. 4, 1890		Brownsword, Frank, Thorn Villa, Heaton Moor, Stockport
Dec. 6, 1888		Brunker, James Edward, M.A. Univ. Dublin, Minore, St. Kevin's-park, Rathmines, Dublin
June 21, 1877	Trans.	Buch, Carl von, 11, Queen Victoria street, E.C., and 1, St. James'-street, S.W.
June 21, 1877		Buchanan, J. Y., F.R.S., 10, Moray-place, Edinburgh
June, 1, 1876		Buckmaster, C. A., 16, Heathfield-road, Mill-hill Park, Acton, W.
Mar. 1, 1852	Trans	‖Buckton, G. B., F.R.S., Weycombe, Haslemere, Surrey
June 20, 1878		Budden, E. Russell, 11, Furnival-street, Holborn, E C.
Dec. 20, 1842		Bullock, Lloyd, 3, Hanover-street, Hanover-square, W.
Feb. 2, 1888		Bunn, Peter Coulson, junr., 18 and 19, Fenchurch-street. E.C.
Dec. 3, 1891		Burford, Samuel Francis, Eastleigh, Queen's-road, Leicester
Dec. 5, 1889		Burgess, John, 7, Wellington-road, Peckham

Date of Election.		
June 19, 1884		Burgess, William Thomas, A.I.C., 1, Ringley Cottages, Blackborough-road, Reigate
Feb. 21, 1884		‖Burland, Jeffrey H., care of B. R., American Bank Note Company, Ottawa, Canada
Mar. 19, 1849	Trans.	Burnard, Charles F., Plymouth Chemical Works, Plymouth
April 15, 1886		Burnett, Edwin, E., 118, Huddleston-road, Tufnell Park, N.
June 4, 1885		Burnett, Joseph Fearon, Worcester street, Oxford
May 4, 1882		Burrell, B. Arthur, 5, Mount Preston, Leeds
Mar. 6, 1890		Burton, William, 45, Liverpool-road, Newcastle, Staffs.
Feb. 21, 1884		Bush, Richard A., Holmdale, Baron grove, Mitcham
Feb. 16, 1882		Bush, Baron William de, Thornleigh, Sydenham Hill, S.E.
Dec. 5, 1889		Butcher, W. F., 32A, Lea-terrace, Blackheath, S.E.
Dec. 4, 1890		Butcher, William J., Fairlight, Knight's Park, Kingston-on-Thames
Dec. 4, 1890		Butler, William Waters, Elmdon, Selly Park, near Birmingham
June 3, 1875		Butterfield, J. C., 79, Endlesham-road, Balham, S.W.
Feb. 18, 1892		Butterfield, W. J. Atkinson, 10, Tressillian-crescent, St. John's, S.E.
Dec. 6, 1888		Byrn, George Alexander, Technical College, 301, Pitt-street, Sydney, New South Wales
Feb. 19, 1891		Byrne, Thomas, 18, Lower Kevin street, co. Dublin
Dec. 1, 1887		Calder, Frank, L.R.C.P. (Lond.), M.R.C.S. (Eng.), Forbes, New South Wales
Dec. 3, 1891		‖Calder, William A. S., 45, Barrington-road, Brixton, S.W.
June 19, 1884		Caley, Edward J., Eaton Old House, Norwich
Dec. 21, 1871		Calvert, J. H., Oakenshaw Print Works, near Accrington
June 17, 1875		Cameron, J. Macdonald, M.P., F.G.S., F.I.C., 5, Raymond-buildings. Grays' Inn, W.C.
Dec. 6, 1888		Campbell. John Morrow, B.Sc., c/o Imperial Bank of Persia, Teheran, Persia
June 7, 1888		Campbell, Rev. Joseph, Coogee, New South Wales
Mar. 20, 1884		Cannon, Matthew, Lavender Hill, S.W.
April 19, 1883		Cannon, W. H., 18 and 19, Fenchurch-street, E.C.
Feb. 5, 1863		‖Carew, R. Russell, Carpender's Park, Watford, Herts, and Oriental Club, S.W.
Feb. 16, 1888	Trans.	Carey, Alfred Edward, M.Inst.C.E., F.R.G.S., F.G.S., 9, Dean's-yard, Westminster. S.W.
May 5, 1892		Carey, Arthur, B.Sc., Browside, Gateacre, near Liverpool
June 20, 1889		Cargill, William D., B.Sc., Loughaugh, near Dundee
Feb. 21, 1889		Carmody, P., Prof., F.I.C., Government Laboratory Port of Spain, Trinidad
May 6, 1875		‖Carpenter, H. S., F.I.C., 32, Holborn-viaduct, E.C.; and Beckington House, Weighton-road, Anerley, S.E.

Date of Election.		
Nov. 17, 1887		Carrington, George, Carrington, Barbadoes, W.I. and Missenden Abbey, Great Missenden, Bucks
June 16, 1864		Carteighe, Michael, 180, New Bond-street, W.
Jan. 17, 1853		Carteighe, John, 3, Hereford square, South Kensington, S.W.
Dec. 5, 1867		||Carulla, F. J. R., 84, Argyle-terrace, Rose Hill, Derby
Feb. 6, 1879		Cassal, C. E., Vestry Hall, Mount street, Grosvenor-square, W.
Mar. 20, 1884		||Cave, Herbert, B.A., Oxon, 11, Pelham-place, South Kensington
Mar. 5, 1874		Chaloner, George, 30, Weston-park, Crouch End, N.
Dec. 2, 1880		Chamberlain, A. G., Rugby
Dec. 20, 1883		Chambres, Gordon Crewe, Rev., Head Master, Wigan Grammar School, Cheshire
Feb. 1, 1883		||Chance, Alexander M., Lawn-side, Edgbaston, Birmingham
Feb. 1, 1872		||Chandler, Charles F., Ph.D., School of Mines, Columbia College, 49th street and 4th-avenue, New York
Feb. 1, 1872		Chandler, William H., Prof, Lehigh University, Bethlehem, Pennsylvania
Feb. 21, 1884		Chantrell, Percy S., 3, Temple-road, Oxton, Cheshire
Feb. 21, 1889		||Chaplin, Edward Mitchell, Westgate, Wakefield
June 17, 1885	Trans.	Chapman, Alfred C., 70, Romola-road, Herne Hill, S.E.
Jan. 16, 1868		Chapman, Edward, 60, High-street, Oxford
Dec. 18, 1884		Chapman, Herbert M., care of W. A. Dawson, Street Farm, Frimley St. Mary, Suffolk
May 7, 1891		Charles, Rhys Pendrill, Plâs Newydd, Neath
Dec. 4, 1890		Cheetham, T. A., Allan Glen's School, 68, North Hanover-street, Glasgow
April 21, 1887		Chenhall, James Warne, Dart Villas, Totnes, South Devon
Dec. 5, 1878		Cheshire, H. F., Public Analysts' Laboratory, Hastings
Jan. 19, 1882		||Chester, Edward D., Nutfield, King Charles-road, Surbiton
Dec. 3, 1891		||Chorley, John C., 85, Haverstock Hill, N.W.
Dec. 16, 1875		Cheverton, George, F.L.S., South Lawn, Tunbridge Wells
Mar. 15, 1888		Chiddey, Alfred, Sabandija Estate, care of Señor Jose M. Restrepo, Honda, Republic of Colombia, S.A.
Jan. 16, 1868		||Child, Gilbert W., Cowley-house, Oxford
Dec. 21, 1871		Childs, Christopher, M.D., Oxon, Lindisfarne, Weymouth
June 18, 1874		Christopher, George, Walkden Works, Verney-road, South Bermondsey, S.E.
Dec. 17, 1885		Christopher, Robert G., 35, Chauntler-road, Custom House, Victoria Docks, E.
Dec. 7, 1882		Chrystal, William J., 7, George-street, Glasgow; and Shawfield Works, Rutherglen, near Glasgow
Mar. 3, 1856	Trans.	Church, Arthur Herbert, F.R.S., Shelsley, Kew, Surrey
April 19, 1888	Trans.	Claisen, Ludwig, Ph.D., Chemisches Laboratorium, Technische Hochschule, Aachen, Prussia
Nov. 20, 1890		Clark, D. G., 44, St. John's Wood Park, N.W.

Date of Election.		
Dec. 7, 1876	Trans.	Clark, John, Ph.D., 138, Bath-street, Glasgow
April 16, 1868		||Clarke, Colonel F. C. H., R.A., 15, Brunswick-place, Brighton
Feb. 16, 1852	Trans.	Claudet, Frederic, 6, Coleman-street, E.C.
April 15, 1886		Clayden, Arthur W., M.A., F.G.S., Warleigh, 131, Palace-road, Tulse Hill Park, S.W.
Dec. 7, 1882		Clayton, E. Godwin, F.I.C., Chemical Laboratory, 43 and 44, Holborn-viaduct, E.C.
Feb. 21, 1889		Clayton, John William, Benfield, Alma-road, Aigburth, Liverpool
Dec. 4, 1873	Trans.	Cleminshaw, Edward, M.A., Alkali Works, Oldbury, near Birmingham
May 20, 1875		Clerk, Dugald, Driffield Villa, Manor Hill, Sutton Coldfield
May 19, 1856		Clift, Samuel, 63, Dudley-road, West Bromwich
Feb. 7, 1878		Cloud, Thomas Charles, A.R.S.M., Walaroo Smelting Works, Walaroo, South Australia
Mar. 18, 1869	Trans.	||Clowes, Frank, D.Sc., University College, Nottingham
Feb. 3, 1887		Coates, William Henry, M.A., M.B., L.S.Sc., M.R.C.S., L.R.C.P., L.S.A., Bleak House, Patrington, Yorkshire
Mar. 6, 1890		Cobbold, Paul Alexander, Warwick School, Warwick
Dec. 18, 1879		Cochran, Michael, M.A., care of Rev. Robert Kirke, D.D., The Manse, Hutten, Berwick-on-Tweed
Dec. 2, 1880		||Cockburn, Arthur Cecil, 22, Streatley-road, Brondesbury, N.
June 16, 1892		Cockerill, Thomas, 105, Derby-street, Bolton
Feb. 16, 1888		Cocking, Lewis Smith, Wharf Mills, Apsley, Huddersfield
Feb. 17, 1881		||Coffin, Walter H., 94, Cornwall-gardens, South Kensington, and Junior Athenæum Club, S.W.
Mar. 5, 1885	Trans.	Cohen, Julius B., Yorkshire College, Leeds
Feb 19, 1891		Cole, Arthur, B.A., Homeleigh, Berkhamsted, Herts
Feb. 19, 1891	Proc.	Colefax, Arthur, Ph.D., B.A., Christ Church, Oxford
April 19, 1883		Coleman, Joseph Bernard, 37, Waldeck-road, Carrington, Nottingham
June 21, 1883		Coleman, Thomas Henry, Regent-street, Wrexham, North Wales
April 21, 1887		Collar, George, B.A., B.Sc., 8, Elytoun-road, Stockwell, S.W.
Mar. 1, 1883		Collenette, Adolphus, 11, Commercial-arcade, Guernsey
Nov. 6, 1873		Collens, Edward, Stourport, Worcestershire
June 16, 1881		Collett, John Marton, 7, Brunswick-square, Gloucester
Feb. 5, 1885	Trans.	||Collie, J. Norman, Ph.D., University College, W.C.
Feb. 16, 1888		Collins, W. Hepworth, Analytical Laboratory, 14 and 15, Bradford-chambers, Mawdsley-street, Bolton-le-Moors
Feb. 18, 1892		||Collins, Hugh Brown, B.Sc., West Balgray, Glasgow
Feb. 6, 1890		Collins, Sydney Hoare, care of Secretary, Revenue and Agricultural Department, Calcutta
Mar. 17, 1887	Trans.	Colman, Harold G., Ph.D., 28, Duchess-road, Edgbaston, Birmingham

Date of Election.		
May 15, 1890		Colwell, James Kear, The College of State Medicine, 101, Great Russell-street, W.C.
May 5, 1892		‖Comyns, Frank B. A., 55, South-street, Durham
June 18, 1891		Congdon, Prof. Ernest A., The Drexel Institute of Art, Science, and Industry, Chestnut-street, Philadelphia, Penn, U.S.A.
Feb. 18, 1875		Connor, Charles C., B.A., Notting-hill House, Malone, Belfast
April 19, 1883		‖Conrad, Edwin C., Portland-road, Gravesend
Feb. 15, 1877		Conroy, Michael, The Hollies, Montpellier-crescent, New Brighton, Cheshire
Jan. 18, 1866	Trans	‖Conroy, Sir John, Bart., F.R.S., Balliol College, Oxford
April 4, 1889		Cook, Edward Barnwell, Rev., Clifton College, Bristol
Dec. 2, 1875	Trans.	Cook, E. H., D.Sc. (Lond.), the Clifton Laboratory, 27, Berkeley-square, Clifton, Bristol
Nov. 5, 1874		Cook, Edward Rider, East London Soap Works, Bow
Nov. 5, 1874		Cook, Henry John, East London Soap Works, Bow
Dec. 4, 1890		Cooke, Arthur William, care of Brotherton and Co., Calder-vale, Wakefield
Feb. 2, 1888		Cooke, F. Barker, F.I.C., Messrs. Bostock and Co., South Dock, Garston, near Liverpool
Feb. 3, 1887		Cooksey, Thomas, Ph.D., B.Sc., 21, Brownswood-park, N.
Nov. 15, 1888		Cooley, Walter Bromley, 5, Dudley-street, Wolverhampton
May 18, 1857		Coomber, Thomas, Rosehurst, Clarendon road, Redland, Bristol
Jan. 17, 1889		Cooper, Albert, Grimston Lawn, Haven Green, Ealing, W.
Feb. 16, 1888		Cooper, Astley, Oaklands Chemical Works, Meanwood-road, Leeds
May 7, 1891		Cooper, Walter Johnson, South Wales Cement Works, Penarth, near Cardiff
April 15, 1880		Copas, Edwin Charles, M.A., Portland House, Soho-hill, Birmingham
May 15, 1890		Copeman, Sydney Monckton, M.A., M.D. (Cantab), Local Government Board, Whitehall, S.W.
Feb. 19, 1891		Corbett, Charles Henry, the Avenue, Trowbridge, Wilts
Mar. 1, 1866	Trans	‖Corfield, W. H., M.A., M.D. (Oxon), F.G.S., Professor of Hygiene and Public Health, University College, W.C., and 19, Saville-row, W.
Dec. 3, 1891		Corey, George Edward, the Drostdy, Grahamstown, South Africa
Dec. 6, 1888		Cornish, Vaughan, the George Hotel, Winchester.
April 17, 1890		Corrie, David, Nobel's Explosives Company, West Quarter Factory, Polmont Station, N.B.
June 15, 1876		Cortis, Arthur B., Worthing, Sussex
Dec. 5, 1889		Coste, F. H. Perry, B.Sc., F.L.S., Analytical Laboratory, 7, Fowkes'-buildings, Great Tower-street, E.C.
June 16, 1892		Couldrey, Henry, H.M.'s Mint, Bombay, India

Date of Election.		
Dec. 17, 1885		Cousins, William J., 11 and 12, Southampton-buildings, Chancery-lane, W.C.
Dec. 16, 1886	Trans.	‖Coutts, Francis J. H., Green Mount, Plymouth-grove, Manchester
Dec. 7, 1882		Cowie, Thomas R., Rangoon Chemical Company, Rangoon
Feb. 6, 1873		Cownley, Alfred J., 13, Fenchurch-avenue, E.C.
April 19, 1888		Cowper, Joseph, 50, King-street, Penrith
Dec. 2, 1886		Cox, Ebenezer John, Orwell Bank, Greenwell-road, Harborne, Birmingham
Dec. 4, 1873		Cox, Samuel Herbert, 13, St. Helen's-place, London, E.C.
Dec. 1, 1870	Trans.	Crafts, Prof. J. M., 59, Marlborough-street, Boston, Mass., U.S.A.
June 3, 1875		‖Crampton, George, St. George's Club, Hanover square, W.
Mar. 16, 1882		‖Crawley, H. Howard, Saugeen, Bournemouth
May 20, 1875		Cresswell, Charles Gerard, Ermyngarth, Ashtead
Mar. 3, 1887		Cribb, Cecil H., B.Sc., 62, Shaftesbury-avenue, W.
April 4, 1889		Cridland, Francis E. J., Analytical Laboratory, 192, Palmerston-buildings, Old Broad-street, E.C.
June 20, 1878		Criper, William Risdon, Cossipore Chemical Works, 3½, Hastings-street, Calcutta
May 20, 1886	Trans.	‖Crompton, Holland, 52, Tournay-road, Walham Green, S.W.
Dec. 3, 1857	Trans.	Crookes, William, F.R.S., 7, Kensington Park-gardens, W., and Athenæum Club, Pall Mall, S.W.
Feb. 6, 1879	Trans.	Cross, Charles Frederick, 4, New-court, Lincoln's-inn, W.C.
Dec. 4, 1890		Crossley, Arthur W., B.Sc. (Vict.), Ph.D., Universitats, Chemisches Laboratorium, Berlin
Dec. 2, 1880		Crow, John Kent, D.Sc., 32, Rosemount-road, Acton, W.
Dec. 1, 1887		‖Crowther, H. Woodward, Beeches-road, West Bromwich
June 19, 1884		Crumbie, William D., 146, Washington-street, East Orange, New Jersey, U.S.A.
Mar. 5, 1874		Cruse, F. V. L., Neva Stearin Works, 65, Schlusselburg-road, St. Petersburg, Russia
Mar. 17, 1887	Trans.	Cundall, J. Tudor, The Academy, Henderson-row, Edinburgh
April 4, 1889		Cunningham, A. Archie, 426, Kearny-street, San Francisco
Dec. 27, 1875		Curphey, W. S., 2, Princes-square, Strathbungo, Glasgow
Feb. 21, 1889		Curragh, John, Donaghadee, Belfast
Dec. 15, 1881		‖Custance, John D., Prof. of Agriculture, Gurnard, Cowes, Isle of Wight
Feb. 16, 1888		Dagger, John H. J., F.I.C., Victoria Villa, Lorne-street, Fairfield, Liverpool
Dec. 7, 1882		Dampier, Henry L., Doddington House, Strood Hill, Rochester, Kent
June 16, 1887		Daniell, L. C., The Standard Brewery, Sydney, N.S.W.
April 15, 1850	Trans.	‖Danson, Joseph, Montreal, Canada
Feb. 18, 1892		Darbishire, Francis V., 59, Elisenstrasse II., Dresden

Date of Election.		
Nov. 15, 1852		Darby, Stephen, 140, Leadenhall-street, E.C
Dec. 3, 1891		Darling, Thomas, 1, Palace street East, Berwick on-Tweed
May 4, 1871		Darling, William Howarth, 126, Oxford-street, Manchester
Jan. 17, 1884		Daubeney, Giles, Rev., Treseo Parsonage, Scilly
April 21, 1887		Dauber, Henry, junr., Balgownie, Victoria-road, Waterloo, near Liverpool
Nov. 18, 1886		Davenport, Bennett F., M.A., M.D., 161, Tremont-street, Boston, Mass., U.S.A.
Nov. 18, 1875		||Davey, G. W., Cambridge-road, Barking, Essex
May 18, 1876		Davidson, Joseph, Holywell-green, Halifax
June 16, 1881		Davies, Alfred Edgar, Mayfield road, Aigburth, Liverpool
Feb. 1, 1866	Trans.	||Davies, Arthur E., Ph D., 15, Queen's-crescent Edinburgh
May 6, 1858	Trans.	Davies, Edward, The Laboratory, 28, Chapel-street, Liverpool
Feb. 16, 1882	Trans.	Davies, G. W., Spring-hill, Stockport
May 5, 1892		Davies, Joseph, 28, Robarts-road. Anfield
Dec. 18, 1873		Davies, Robert Higgins, Apothecaries' Hall, Blackfriars, E.C.
Dec. 17 1857		||Davis, J. Frederick, F.G.S., Archbrook, Budleigh-Salterton, Devon
June 6, 1872	Trans.	||Davis, Richard Hayton, 26, Regent-parade, Harrowgate
Jan. 20, 1876		Davis, T. Sebastian, 199, South Lambeth-road, S.W.
Dec. 7, 1876		|Davis, Walter Charles, Westbury House, Westbury Park, Bristol
Feb. 2, 1888		Day, Albert Wodehouse, B.A., 38, Hava-villas, West Brighton
Nov. 20, 1890		Day, Charles Edwin, 145, Abbey-road, Barrow-in Furness
Mar. 17, 1881	Trans.	||Day, T. Cuthbert, 36, Hillside-crescent, Edinburgh
Mar. 3, 1859	Trans.	Debus, Heinrich, Ph.D., F.R.S., 1 Obere Sophien strasse, Cassel, Provinz Hessen, Germany
May 7, 1885	Trans.	Dechan, Martin, Chemical Laboratory, 5. Oliver-place. Hawick
Dec. 3, 1874		Deck, Arthur, 9, King's-parade, Cambridge
April 1, 1869	Trans.	Deering, W. H., 13, Hervey-road, Kidbrook Park-road, Blackheath, S.E.
Dec. 15, 1881		Demarcay, Eugene Anatole, 75, Rue de Courcelles, Paris
Mar. 6, 1890		Dennant, John, F.G.S., Lyndhurst Crescent, Glenferrie, Melbourne
Dec. 1, 1870	Trans.	Dewar, James, Prof., F.R.S., Brook-side. Cambridge
Mar. 4, 1886		||Dey, Preo Loll, 4, Beadon-street, Calcutta
June 17, 1880		Dey, Rai Kanny Loll, Bahadoor, C.I E., 4, Beadon-street Calcutta
April 15, 1880		Dibdin, W. J., F.I.C., Mayfield, Grange-road, Sutton Surrey
Dec. 1, 1887		Dickson, T. Arthur, Estate Office, Overstone Park, Northampto
April 18, 1872		Dickenson, Arthur John, F.I.C., 4, Shadeloes-road, New Cros S E.
Jan. 17, 1889		Dinsberg, Dr Carl, Elberfield, Germany
June 17, 1886		Diogo, Prof. A. C, Hospital Militar, 29 Rua do Evaristo da Veig Rio de Janeiro

Date of Election.		
Feb. 2, 1860	Trans.	‖Divers, Edward, Prof., M.D., F.R.S., Hongo, Tokyo, Japan
Feb. 5, 1885	Trans.	Dixon, Augustus Edward, M.D., Queen's College, Cork
Feb. 3, 1876	Trans.	‖Dixon, Harold B., F.R.S., Owen's College, Manchester
Dec. 18, 1862		Dixon, W. A., Technical College, 301, Pitt street, Sydney, New South Wales
Jan. 17, 1889		Dixon, W. Hepworth. Heatherdale. Woodford Green, Essex
April 17, 1890		Dixon, William, 3, Belle Vue Park, Sunderland
June 15, 1882	Trans.	Dobbie, James Johnstone, M.A., D.Sc. University College, Bangor, Wales
Mar. 3, 1887		Dobbin, Leonard, Ph D., Chemical Laboratory, New University-buildings. Edinburgh
Dec. 2, 1875	Trans.	Dodd, T. H., Chemical Department, Royal Arsenal, Woolwich, S.E.
April 19, 1888		‖Dodd, William Henry, 8, Kempson-road, Telbrook. Fulham. S.W.
Nov. 18, 1886		Dodd, W. Ralph, 2, St. Andrew's-pavement. Dunmore-road, Amhurst park, N.
May 5, 1892		Dodds, George Price, Eversley-place. Heaton, Newcastle-on-Tyne
May 5, 1892		Donaldson, Hudson, Trevyr House, Grantham
Feb. 19, 1891		Donovan, Hendric Thomas, Crumpton-street, Bridgetown, Barbadoes, B.W.I.
May 20, 1886		Doran, Robert Elliott, 1, Goldsmith-terrace, Bray. co. Wicklow
May 20, 1886		Dormer, Richard, Garston.
Dec. 5, 1889		Dott, David Brown, 7, Victoria-terrace, Musselburgh, N.B.
Dec. 6, 1888		Douglas, William, A.I.C., Diamond, British Guiana, Demerara
Nov. 20, 1884		Down, Frederick J., 28, Victoria-road, Old Charlton, Kent, S.E.
Feb. 3, 1887		Downes, Arthur H., M.D., Local Government Board, Whitehall, S.W.
Mar. 17, 1859	Trans.	Draper, Harry N., Palmerston-park, Upper Rathmines, Dublin
Feb. 21, 1884		Draper, Henry Carter, 2, Orwell-park, Rathgar, Dublin
June 18, 1891		Dreaper, W. Potter, Crape Silk Works, Ponders End, Middlesex, N.
March 4, 1886		Dresel, Adolphe, c/o Société anonyme des Plombs argentifères d'Asprières, St. Martin de Bouilac, Aveyron, France
Dec. 4, 1890		Dudley, William L., Professor, Nashville, Tennessee, U.S.A.
May 5, 1892		Duffield, Walter William, 24, Ursula-road, Battersea, S.W.
Feb. 21, 1884		Duggan, T. R., Sunny-bank, Vanbrugh-hill, Westcombe park, Blackheath, S E.
Dec. 5, 1889		Dukes, Thomas William, c/o Dukes Bros., Caledon and Primrose-street, Cape Town. Africa
June 16, 1881		Duncan, Arthur William, c/o Messrs. Woolley, Sons, & Co., 69, Market-street, Manchester
Dec. 17, 1863		Duncan, James, 9, Mincing-lane, E.C.
June 18, 1891		Duncan, William, The Laboratory, 65, Bath-row, Edgbaston, Birmingham

Date of Election.		
June 7, 1888	Proc.	Dunn, John, B.Sc., Morgan Academy, Dundee
Dec. 7, 1882		Dunn, J. T., M.Sc., The School, Gateshead-on-Tyne
Dec. 3, 1885		Dunstan, M. J. R., 9, Hamilton Drive, The Park, Nottingham
Dec. 18, 1879	Trans.	Dunstan, Wyndham, Prof., 17, Bloomsbury-square, W.C.
Jan. 19, 1860	Trans.	Dupré, August, Ph.D., F.R.S., Westminster Hospital Medical School, Caxton street, Westminster, S.W.
Feb. 16, 1860		Dupré, Frederick, Ph.D., Stassfurt, near Magdeburg, Germany
June 1, 1871		||Durham, Henry, City of London School, Victoria Embankment, E.C.
Dec. 6, 1883		Durrant, Reginald G., B.A., The College, Marlborough, Wilts
Dec. 6, 1883		Dutta, Ramchandra, Medical College, Calcutta
Dec. 15, 1892		Duxbury, Thomas, The Corporation Gas Works, Darwen
Dec. 16, 1875		||Dyer, Bernard, D.Sc. (Lond.), 17, Great Tower-street, E.C.
Feb. 6, 1890	Trans	Dymond, Thomas Southall, Chelmsford
Nov. 19, 1885		Dyson, Gibson, Ph.D., Temple House, Cheetham Hill, Manchester
Mar. 1, 1883	Trans.	Dyson, Septimus, 2, Exchange-place, Middlesbrough
Dec. 7, 1882		Earl, Alfred George, M.A., Science-buildings, Tonbridge School, Tonbridge
Feb. 1, 1876		Earp, Francis S., Ph.D., Gawler, South Australia
April 4, 1889	Trans	Easterfield, Thomas Hill, 5, St. Andrew's Hill, Cambridge
Dec. 3, 1891		Eastick, Charles E., Myrtle Bank, Leyton, E.
Feb. 1, 1881		Eastick, John J., Manager, Australasia Sugar Refining Co., Melbourne, Australia
Dec. 5, 1878	Trans.	Eccles, Herbert, Briton Ferry, Glamorgan
Mar. 17, 1881		Edgell, R. Arnold, M.A., 66, Warwick-road, South Kensington, S.W.
June 1, 1876		Edmunds, James, M.D., 29, Dover street, Piccadilly, W.
June 22, 1888		Edmunds, Lewis, Barrister-at-Law, 1, Garden-court, Temple, E.C., and 60, Park-street, Park-lane, W.
Feb. 7, 1848	Trans.	||Edwards, John B., Ph.D., Montreal
Dec. 5, 1889		Edwards, Robert Stephen, B.A., Mosley House, Gelert-street, Carnarvon
Feb. 21, 1884		Edwards, Vincent, Lawes' Chemical Manure Co., Barking Creek, Essex
May 5, 1892		Edwards, Walter N., 4, Herne Hill-road, Camberwell, S.E.
June 16, 1887		||Ehrhardt, Ernest Francis, D.Sc., Ph.D., A.M.C. Anilinfabrik, Ludwigshafen-am-Rhein
Nov. 20, 1884		Ehrmann, Leon, The Mauritius Engrais Chemiques Co., Port Louis, Mauritius
Dec. 1, 1864	Trans.	Ekin, Charles, 143, New Bond-street, W.
Dec. 20, 1883		Ekins, Arthur E., Market-place, St. Albans
Nov. 17, 1887		Elborne, William, Richmond Villa, Station-road, Cambridge

Date of Election.		
Dec. 3, 1891	Trans.	Elford, Percy, 24, Beaumont-street, Oxford
Feb. 7, 1878		Elliott, Arthur H., Ph.D., 591, Broadway, New York City, U.S.A.
Dec. 3, 1885		Ellis, George E. R., Kootenai, Idaho, U.S.A.
April 17, 1890		Ellis, Thomas Flower, The Straits Trading Co., Pulo Brani Smelting Works, Singapore
Feb. 7, 1878		Ellis, W. H., School of Practical Science, Toronto, Ontario, Canada
May 5, 1892		Ellison, Henry, junr., Whitechapel-road, Cleckheaton
Mar. 15, 1888		Ellwood, Thomas Ashcroft, Kerswell, Cavendish-road, Harringay, N.
Mar. 4, 1886	Trans.	Elworthy, Herbert Samuel, Punjab Sugar Works, Sujanpur, viâ Pathankot, Punjab, India
Feb. 5, 1885		Embrey, George, Oriel Lodge, Tuffleigh, near Gloucester
Feb. 3, 1887		||Emmons, Hamilton, c/o N. H. Emmons, Esq., 40, Water-street, Boston, Mass, U.S.A.
June 16, 1892		Entwistle, Herbert, Cross terrace, 476, Padiham-road, Burnley
Dec. 3, 1885		Epps, James, junr., Norfolk House, Beulah Hill, Upper Norwood, S.E.
Dec. 5, 1889		Erskine, J. Kerr, Albert Mine, Box 220, Pretoria, S.A.R., Transvaal, South Africa
June 21, 1883	Trans.	Esilman, Alexander, Fleetwood Lodge, 25, Roe-lane, Southport
May 1, 1862		||Esson, William, Merton College, Oxford
Feb. 2, 1865		||Estcourt, Charles, St. Andrew's-chambers, 20, Albert-square, Manchester
Feb. 2, 1888		||Estcourt, Philip Anderson, Chemical Laboratory, 20, Albert-square, Manchester, and Vyrnew House, Talbot-road, Old Trafford, Manchester
Mar. 17, 1887		Evans, Alfred J., M.A., B.Sc., 453, Romford-road, Forest Gate, E.
May 7, 1891		Evans, Frederick Arthur, The Cape Copper Co., Ookiep, Namaqualand, Cape of Good Hope
June 15, 1876		Evans, Gwilyn, 7, Stepney-street, Llanelly, South Wales
May 17, 1888		Evans, George Thomas, The Terrace, Rhymney, Mon.
Feb. 21, 1889		||Evans, Philip Norman, Ph.D., 28, Great Ormond-street, W.C.
June 16, 1892		Evans, Sir John, K.C.B., F.R.S., Nash Mills, Hemel Hempstead
Dec. 6, 1888		||Everard, Arthur George, 27, Northcote-road, Clapham Junction, S.W.
Feb. 17, 1876		Faber, H. M., Rev., 1, College-grounds, Malvern
Mar. 15, 1888		Faber, Harald N., Fiona, Lennard-road, Penge, S.E.

Date of Election.		
May 15, 1890		Fairgrieve, Andrew, 40, Marchmont-crescent, Edinburgh
May 18, 1865	Trans.	‖Fairley, Thomas, F.R.S.E., 8, Newton-grove, Leeds, and 16, East-parade
Feb. 1, 1883		Fallon, J. H. M., c/o. Peruvian Corporation, Ltd., Lima, Perú
Nov. 15, 1888		Farlie, John B., 128, Eglington-road, Plumstead, S.E.
Feb. 6, 1890		Farquharson, A. C., County Asylum, Lichfield
Dec. 1, 1870		Farries, Thomas, 16, Coleman-street, E.C.
Dec. 2, 1880		‖Farrington, Thomas, M.A., 4, Waterloo-place, Cork
Dec. 1, 1887		Fawsitt, Charles A., 9, Foremount-terrace, Dowanhill, Glasgow
June 7, 1888		Featherstone, W. Burns, Mansion House, Moseley, Birmingham
May 17, 1888		Fell, John Campbell, 188, Stanhope-street, Regent's-park, N.W.
Dec. 5, 1878	Trans.	Fenton, H. J. H., M.A., Christ College, Cambridge
June 20, 1872		‖Ferguson, John, M.A., University of Glasgow
Feb. 4, 1864		‖Ferreira, A. A., M.P.S., Rio de Janeiro, Brazil
Feb. 21, 1889		Ferrier, David, Edinburgh-terrace, Edinburgh-road, Perth
Nov. 16, 1882		Ferrier, James, care of Dr. David Ferrier, 34, Cavendish-square, W.
Dec. 4, 1873		Field, Charles L., Upper Marsh, Lambeth, S.E.
May 15, 1890		Findlay, George H., The Brewery, Boro' Bridge, Yorks
Mar. 7, 1872	Trans.	‖Fisher, Walter William, M.A., 5, St. Margaret's-road, Oxford
April 3, 1873		Fison, Edward Herbert, Stoke House, Ipswich
April 18, 1872		Fison, Frederick William, M.A., 98, Cromwell-road, S.W.
Dec. 19, 1867		Fletcher, A. E., 13, Christchurch-road, Crouch End, N.
April 16, 1874		Fletcher, Frederick W., North London Chemical Works, Holloway, N., and Beauchamp Lodge, Enfield
Dec. 3, 1885		‖Fletcher, Lazarus, M.A., 36, Woodville-road, Ealing, London, W.
April 18, 1872	Trans.	‖Fletcher, Thomas William, Museum-street, Warrington
Feb. 18, 1892		Floris, Robert Brooks, 18, Ridgway-place, Wimbledon, S.W.
June 16, 1859		Fogg, Thomas, 6, Clarendon-gardens, Maida-vale, W.
Dec. 5, 1889		Foggie, John, University College, Dundee
May 7, 1885		Follows, Harold, 142, Embden-street, Manchester
Feb. 21, 1853		Foord, George, Royal Mint, Melbourne, Australia
Nov. 19, 1874		Forbes, James, jun., 165, Fenchurch-street, E.C.
Dec. 5, 1889		Ford, John S., care of Messrs. W. Younger and Co., Abbey Brewery, Edinburgh
Mar. 4, 1886		Formoy, James Arthur, 12, Railway-approach, London Bridge
Dec. 15, 1892		Forster, Dr. Martin Onslow, 44, Francis-road, Edgbaston, Birmingham
Dec. 6, 1888		Forth, Henry, 17, Herbert-road, Sherwood-rise, Nottingham
Mar. 3, 1856		Forsyth, William Cay, 128, Wellington-road, Heaton Norris, Lancs.
April 6, 1865		Foster, Dr. M., F.R.S., Trinity College, Cambridge
April 4, 1872		Foster, Reginald Le Neve, The Firs, North-road, Droylsden, near Manchester

Date of Election.		
Jan. 18, 1872	Trans.	Foster, William, M.A., Middlesex Hospital, W.
May 7, 1891		Foster, John Alfred, The Laboratory, H.M.'s Dockyard, Portsmouth
Feb. 2, 1888	Trans	||Foster, G. C., F.R.S., 18, Daleham-gardens, Hampstead, N.W.
May 7, 1892		Fowler, Gilbert J., Dalton Hall, Victoria Park, Manchester
Mar. 16, 1882		Fowler, William, 1, Grace-terrace, Sunderland
June 19, 1884		||Foye, Martin Hugh, Townavoltry, Tubbercurry, co. Sligo, Ireland
June 21, 1877		Franchimont, A. E. N., Ph.D., Leiden, Holland
Dec. 18, 1879		Francis, Edward, Rock-villas, Derby-road, Nottingham
Nov. 6, 1873		||Francis, G. Bult, 38, Southwark-street, S.E.
Nov. 7, 1842	Trans.	Francis, William, Ph.D., F.L.S., Manor-house, Richmond, Surrey, and Red Lion-court, Fleet-street, E.C.
Dec. 20, 1847	Trans.	||Frankland, E., D.C.L., F.R.S., The Yews, Reigate-hill, Reigate
June 16, 1881		Frankland, Henry, Streonshalk, Linthorpe, Middlesbro'
Dec. 2, 1880	Trans.	||Frankland, Percy Faraday, Ph.D., F.R.S., University College, Dundee
Mar. 21, 1867		||Fraser, Dr. Angus, 232, Union-street, Aberdeen
May 5, 1892		||Fraser, James C., Victoria-square, Adelaide, South Australia
May 7, 1885		Freear, Harry M., Hedgefield, Harpenden, Herts
June 16, 1887		Freeman, Frederick W., 7, Park Hall-place, East Finchley
Mar. 7, 1867		Freeman, J. Hersee, Stratford House, Stratford, E.
April 4, 1889		Freestone, Joseph T., 5, Kerfield-terrace, New Ferry-road, New Ferry, Cheshire
April 4, 1889	Trans.	Frew, William, c/o Herrn Hummel, Theresienstrasse 21, München, Bayern, Germany
Feb. 2, 1871	Trans.	||Friswell, R. J., 115, Darenth-road, Stamford Hill, N.
Dec. 18, 1884		Frost, Joe, Moldgreen, Huddersfield
Nov. 20, 1890		||Frost, Robert, Brightside, Altringham
April 15, 1880		Fryer, Alfred Cooper, Ph.D., M.A., F.R.H.S., Cornwallis Lodge, Clifton, Bristol
Dec. 3, 1891		Fulcher, Lionel William, B.Sc., South Kensington Museum, S.W.
Dec. 2, 1886		Fuller, John, Rookwood, Chapter-road, Willesden Park, N.W.
Mar. 1, 1883		Fulton, H. B., 33, St. Dunstans-road, West Kensington, W.
Feb. 18, 1892		Gailleton, Alfred T., Tulloch House, Perth, N.B.
Dec. 1, 1887		Galbraith, D. R. Shirreff, Analytical Chemist, Auckland, New Zealand
April 19, 1866		Gale, James, Ph.D., M.A., F.G.S., Galeston, Eton-avenue, South Hampstead
April 5, 1852		||Gale, Samuel, 225, Oxford-street, W.
Dec. 20, 1847	Trans.	Galloway, Robert, 60, Pembridge-villas, Bayswater

Date of Election.		
Mar. 4, 1875		||Galton, Douglas, Sir, K.C.B., F.R.S., 12, Chester-street, Grosvenor-place, W., and Himbleton Manor, Droitwich
Mar. 17, 1851		||Gamble, David, Colonel, C.B., St. Helens, Lancashire
April 6, 1876		Gamble, J. C., St. Helens, Lancashire
Dec. 6, 1883		||Garbutt, Llewellyn M.D., The College, Winchester
Mar. 15, 1888		Gardiner, James H., 59, Wroughton-road, Balham, S.W.
June 21, 1877		Gardner, John, 3, Hanover-street, Hanover-square, W.
Nov. 15, 1888		Gardner, Walter M., The Yorkshire College, and 28, Cliff-road, Leeds
May 5, 1892		Gargari, Haridas, M.A., Agra College, Agra, India
Jan. 17, 1889		Garrett, Frederic Chas., B.Sc., College of Science, Newcastle-upon-Tyne
Jan. 20, 1876		||Gaskell, Ernest Holbrook, 5, The Grove, Highgate, N.
April 17, 1884		Gaskell, Joseph, 1, Woodlands-road, Cheetham-hill, Manchester
Jan. 18, 1847		Gatty, F. A., Holland Bank, Accrington, Lancashire
Nov. 4, 1875		Gee, T. Ernest, M.R.C.P., 67, Westbourne-park-road, W.
Feb. 6, 1890		Gee, W. W. Haldane, B.Sc. Lond., 124, Raby-street, Moss Side, Manchester
Mar. 3, 1887		Geisler, Joseph F., Ph.C., Mercantile Exchange Buildings, Hudson and Harrison-streets, New York
May 7, 1885		Gemmell, George Harrison, 4, Lindsay-place, Edinburgh
April 17, 1879		Gent, William Thomas, Misterton, Gainsborough
Feb. 21, 1889		||Gerland, Conrad, M.Sc., Ph.D., Chemical Laboratory Technical School, Blackburn; and Accrington
Dec. 3, 1891		German, George, Junr., Huntingdon House, Ashby-de-la-Zouch
Feb. 16, 1888		Gerrans, Benjamin H., jun., 47, Aubert Park, Highbury, N.
Nov. 4, 1875		Gerrard, A. W., 1, Cantlowes-road, Camden-square, N.W.
Dec. 6, 1888		Geyzel, John Lawrence Van, Surgeon-Major, Chemical Examiner, Madras, East India
Feb. 6, 1890		Gibbes, Cuthbert C., M.D., M.C., L.R.C.P. Lond., D.P.H. Cantab., F.G.S., F.L.S., 3, Wyburn-villas, Surbiton, S.W.
May 7, 1891		Gibbins, Bevington H. Ocata, Florida, U.S.A.
Feb. 18, 1864		Gibbons, Sydney, Faraday House, East Melbourne, Victoria
May 16, 1889		Gibbs, William Taylor, Buckingham, Que, Canada, viâ New York
Mar. 5, 1885		Gibson, Adam, c/o Messrs. Pinkerton, Gibson & Co., Thistle-street-lane, East Edinburgh
Feb. 21, 1884		Gibson, George W., Headingley, P.O., near Winnipeg, Manitoba, Canada
June 16, 1892		Gibson, John Ph.D., F.R.S.E., F.I.C., 15, Hartington Gardens, Edinburgh
June 21, 1888		Gibson, W. Humphrey, 107, King's-road, Brighton
May 18, 1841	Trans.	Gilbert, Joseph Henry, Ph.D., F.R.S., F.L.S., Harpenden, St. Albans

Date of Election.		
April 3, 1862	Trans.	Gill, C. Haughton, Sunnydene, Stonard-road, Palmer's green, N.
Feb. 1, 1883		||Gill, E. Clarendon, Ashford Villa, Gresham - road, Staines, Middlesex
Mar. 17, 1881		Gill, E. J. G., Wellikuppam, Madras Presidency, India
April 19, 1888		Gill, John, Gwealhellis, Helston, Cornwall
April 6, 1865		||Gillman, A. W., Castle Brewery, St. George's-road, Southwark
Dec. 3, 1885		Girdwood, Gilbert P., M.D., 54, Beaver Hall Hill, Montreal, Canada
Dec. 18, 1848	Trans.	Gladstone, John Hall, Ph.D., F.R.S., 17, Pembridge-square, Hyde Park, W.
Mar. 4, 1886		Glenfield, Francis W. S., 69, Connaught-street, Hyde Park-square, W.
Jan. 18, 1872		Glover, George Thomas, The Phospho-Guano Company, Seacombe, Cheshire
April 4, 1878		Goldschmidt, S. A., Ph.D., care of Columbia Chemical Works, 43 to 57, Sedgwick-street, Brooklyn, New York
May 16, 1889		Goldsmith, Byron B., 19, East 74th-street, New York City, U.S.A.
Dec. 4, 1890		Goodwin, Thomas S., Montgomery Cottage, Newton, Glasgow
Nov. 20, 1890		Gordon, Colin, Messrs. McDougall Bros., Mills, Millwall Docks, E.
April 21, 1887	Proc.	Gordon, Hugh, B.A. Oxon., 3, Courtfield-gardens, S.W.
Mar. 4, 1875		Gordon, J. G., Queen Anne's Mansions, Westminster, S.W.
Mar. 6, 1890		Gossling, Frank, B.Sc., Condebec, Park Side, Hampton Wick
Feb. 1, 1883		Gothard, Frederic, 205, Ashby-road, Burton-on-Trent
Jan. 17, 1889		||Gott, B.S., B.A., Corinium, St. Mark's, Cheltenham
Feb. 6, 1879		Gough, Thomas, Rev., B.Sc. (Lond.), King Edward's School, Retford, Notts
June 16, 1887		Gover, Herbert J., 29, Piccadilly, Hanley, Staffordshire
Jan. 17. 1889		Gow, Robert J., Halebank-terrace, Ditton, Widnes
Feb. 2, 1871	Trans.	||Gowland, William, Buena Vista, Frodsham, Cheshire
Feb. 3, 1887		Goyder, George A., Survey Office, Adelaide, South Australia
June 19, 1884		Grace, W. F., 54, York-road, Hove, Brighton
Feb. 6, 1879		Gracey, Robert, Faircombe, The Barnfield, Exeter
April 15, 1880	Trans.	||Graham, C. Colborne, care of Messrs. Blundell, Spence, and Co., Beverley-road, Hull
May 1, 1862	Trans.	||Graham, Charles, D.Sc., 23, Euston-buildings, Gower-street Station, N.W.
Feb. 6, 1890		Grant, James, Moss View, St. Mary's-road, Moston, Manchester
June 16, 1887		Gravill, Edward D., F.R.M.S., 6, Addington-road, Stroud Green, N.
Dec. 7, 1882		Gray, George, Canterbury College, School of Agriculture, Lincoln, New Zealand
Feb. 19, 1891		Greaves, Robert Bond, 77, Netheredge road, Sheffield
Dec. 4, 1890		Green, Alfred H., Oaklands, Lowton St. Mary's, Newton-le-Willows

Date of Election.		
Feb. 5, 1885	Trans.	Green, Arthur George, Atlas Works, Hackney Wick, E.
June 16, 1887		Green, John Edward, F.I.C., A.R.S.M., 52, Claypath, Durham
Dec. 5, 1878		Green, Herbert, Hayle Mill, Maidstone
Dec. 5, 1878		Green, Lawrence, Lower Tovil, Maidstone
Dec. 3, 1885		Greene, William H., M.D., 204, North 36th-street, Philadelphia
April 2, 1874	Trans.	Greenaway, A. J., 50, Frognal, Hampstead, N.W.
June 4, 1885		Greenway, Thomas J., 8th Avenue, East Adelaide, South Australia
April 17, 1884		Greenish, Henry G., 20, New-street, Dorset-square, N.W.
May 18, 1871		Greenish, Thomas, F.R.M.S., 20, New-street, Dorset-square, N.W.
May 15, 1873		Greenwood, William Henry, Birmingham Small Arms and Metal Co., Adderley Park Works, Birmingham.
June 18, 1891		Gregory, Alfred John, M.D., B.Sc., 20, Streatham-place, Streatham Hill, London, S.W.
May 7, 1885		Gregory, G. M. Ghazipur, N.W.P., India
April 21, 1887		Gregory, W., Steam Brewery, Dartford, Kent
Mar. 1, 1883		Grenfell. Claud, M.A., 29, Chester-square, S.W.
Mar. 5, 1874		Grevile, Henry Leicester, Diersheim, Churchfields, Woodford, Essex
April 17, 1884		Grey, William J., 10, Tynevale-terrace, Gateshead
Feb. 2, 1888		Griffith, D. Agnew, c/o Titan Soap Co., Lydia Ann-street, Liverpool
June 16, 1859		Griffith, George, Druries, Harrow
Dec. 15, 1881	Trans.	Griffiths, Arthur Bower, Ph.D., F.R.S.E., Richmond House, Charlotte-road, Edgbaston, Birmingham
April 17, 1879		Griffiths, Thomas, Bowyer House, Bowyer-terrace, Clapham, S.W.
Feb. 19, 1874	Trans.	Grimshaw, Harry, Gibbons-street Chemical Works, Bradford, Manchester
April 15, 1880		Grimwood, Robert, London County Council, Chemical and Gas Department, 40, Craven-street, W.C.
Dec. 5, 1889		Gripper, Harold, 2, Heald-place, Rusholme, Manchester
April 6, 1871	Trans.	Groves, Charles Edward, F.R.S., Kennington-green, S.E.
Dec. 17, 1857		Groves, T. B., Weymouth
April 20, 1871		Grundy, Cuthbert Cartwright, F.L.S., South Shore, Blackpool, Lancashire
Jan. 17, 1889		Gudeman, Edward, Ph.D., P.O. Box 3001, New York City, U.S.A.
Dec. 6, 1888		Guthrie, Frederick Bickell, Chemical Laboratory, The University New South Wales
Nov. 4, 1875		Guyer, James Brett, Wrentham, Higher Erith-road, Torquay
June 4, 1874		Habirshaw, W. M., 159, Front-street, and 315, Madison-avenue, New York City, U.S.A.

Date of Election.		
Feb. 7, 1878		‖Hadkinson, John, Teheran, Persia
Dec. 16, 1886	Trans.	Haga, T., No. 1, Sadowara-Cho, Tokyo, Japan
June 16, 1881		Hailes, Alfred James de, St. Clair, 92, Manor-road, Stoke Newington, N.
Jan. 20, 1876	Trans.	Hake, H. Wilson, Ph.D., Westminster Hospital, S.W.
Dec. 3, 1891		Hall, A. D., 38, Franconia-road, Clapham Common, S.W.
Jan. 17, 1889		Hall, Allan T., Inglebank, Newlands, Hull
Dec. 3, 1891		Hall, Archibald, 34, Bishopsgate-street, E.C.
Mar. 3, 1887		Hall, Edgar, Albert-street, Brisbane, Queensland
April 4, 1889		Hall, James, B.A., B.Sc., Bancroft's School, Woodford, Essex
Dec. 1, 1887		Hall, J. C. August, c/o J. C. Hall, Esq., Poste Restante, Box 172, Durban, Natal, South Africa
Jan. 17, 1889		Hall, John A., 108, Lloyd-street, Greenheys, Manchester
May 3, 1866		‖Hall, Marshall, Capt., Easterton Lodge, Parkstone, R.S.O., Dorset
June 1, 1876		Hall, Samuel, East London Soap Works, Bow
Dec. 18, 1884		Hall, Thomas P., M.A., Ph.D., Clark University, Worcester, Mass., U.S.A.
May 20, 1886		Halliburton, William Dobinson, M.D. Lond., B.Sc. Lond., F.R.S., M.R.C.P., M.R.C.S., 9, Ridgmount-gardens, Gower-street, W.C.
Dec. 2, 1875		Halse, William, 16, Mark-lane, E.C.
Feb. 3, 1859		‖Hambly, C. H. Burbidge, Holmeside, Hazelwood, near Derby
April 17, 1890	Trans.	Hambly, Frederick J., University College, Dundee
June 7, 1888		Hamilton, James C., Trinity Lodge, Edinburgh
May 6, 1875	Trans.	Hamlet, W. M., Government Laboratory, Macquarie-street, Sydney, N.S.W.
Dec. 7, 1882		Hammersley, W. A. Leslie, Bridge House, Leek, Staff.
Jan. 18, 1877		Hampton, William, 38, Lichfield-street, Hanley
Feb. 7, 1857		Hanbury, Cornelius, Plough-court, Lombard-street, E.C., and Dynevor House, Richmond, Surrey
Mar. 7, 1872	Trans.	Hannay, James Ballantine, Cove Castle, Loch Long, N.B.
Feb. 21, 1889		‖Hanson, Alfred Miall, The Marjorie, Whalley, near Blackburn
Feb. 3, 1859	Trans.	‖Harcourt, A. Vernon, M.A., F.R.S., Cowley Grange, Oxford
April 16, 1863		‖Harcourt, L. F. Vernon, M.A., Fairholme, Weybridge
Mar. 17, 1887		‖Harden, Arthur, Ashville, Upper Chorlton-road, Manchester
May 7, 1885		Hards, William Benjamin, B.A. Lond., St. John's College, Battersea, S.W.
Jan. 20, 1876		Hargreaves, James, Peel House-lane, Farnworth, near Widnes, Lancashire
June 19, 1884		Hargreaves, John, Widnes, Lancashire
Dec. 16, 1875		Harkness, William, Laboratory, Somerset-house, W.C.
June 1, 1876		Harland, R. H., 37, Lombard-street, E.C.
Feb. 7, 1878		‖Harland, William Dugdale, 48, King-street, Manchester

Date of Election.		
Mar. 2, 1857		‖Harley, George, M.D., F.R.S., 25, Harley-street, Cavendish-square, W.
Jan. 15, 1874		‖Harman, Frederick Edwin, M.R.A.C., care of Dr. Piggott, Orchard-gardens, Teignmouth, Devon
Dec. 15, 1881		Harrington, William Bury, Ardsullagh, Old Blackrock-road, Cork
Feb. 21, 1884		Harris, Frank W., Laboratory, G.W. Ry., Swindon, Wilts
Dec. 17, 1874		Harris, Henry Penley, 61, Ladbroke-grove-road, North Kensington, W.
Dec. 2, 1886		Harris, Sydney Joseph, Leeds School of Science and Technology, Rossington-street, Leeds
Feb. 7, 1878		‖Harris, Thomas Frederick, B.Sc., Stuartdene, College-road, Bromley, Kent
May 17, 1888		Harrison, Albert, 72, Windsor-road, Forest Gate
June 21, 1883		‖Harrison, Hugh Erat, B.Sc., Leigh Chambers, Gt. Ormond-street, W.C., and Faraday House, Charing Cross-road
May 17, 1888		Harrison, J. Burchmere, Government Laboratory, British Guiana
Feb. 19, 1891		Harrold, Frederick W., 12, Hereford-gardens, Park-lane, W.
Feb. 17, 1876	Trans.	Harrow, G. H, Ph.D., The Brewery, Messrs. Allsops & Sons, Burton on-Trent
Mar. 4, 1886		Hart, Bertram Harvey, The Elms, Old Charlton, Kent, S.E.
Jan. 21, 1869	Trans.	Hart, F. W., Esq., Holly House, 96, Stoke Newington-road, N.
Mar. 15, 1888		Hart, James, 131, Embden-street, Manchester
Dec. 6, 1883		Hart, Thomas, 166, Blackburn-road, Bolton
May 7, 1891		Hart, William Beaumont, Gransmoor Avenue, Fairfield, near Manchester
Mar. 16, 1882		Hartley, Arthur, Cannon Brewery, Brighton
Dec. 20, 1866	Trans.	Hartley, Walter Noel, Prof., F.R.S., Royal College of Science, Stephen's-green, Dublin ; and 36, Waterloo-road, Dublin
Feb. 6, 1890		Hartog, P. J., B.Sc., Owens College, Manchester, and 6, Greville-road, London, N.W.
Dec. 3, 1885		Harvey, Ernest W., A.R.S.M. Hilsrig, Alderbrook-road, Balham, S.W.
Feb. 17, 1881		Harvey, Sidney, Canterbury
Nov. 20, 1890		Haslam, Arthur R., Ph.D., Roseville, 39, Sydney-avenue, Blackrock, co. Dublin
May 6, 1875		Hastings, Henry Mitchell, 54, Edith-road, The Cedars, West Kensington
Dec. 6, 1892		Hatton, William Percy, care of W. R. Hatton and Sons, Wormwood Scrubs
Nov. 2, 1880		Hawkes, Alfred E., M.D. Bruss., L.R.C.P. Edin., 22, Abercromby-square, Liverpool
June 2, 1888		Hawkins, Lewis Walter. 20 Norton Folgate, London, E.
Mar. 3, 1887		Hay, Alexander, Norwood House, 29, Brook-road, Bristol

Date of Election.		
April 15, 1880		Haydon, William Frederick, The Exchange, Birmingham
Dec. 1, 1887		Head, C. James, F.I.C., care of W. L. Fransmith and Co., Ostrow Galodai, Uralskaja, Nos. 3, 4, 6, St. Petersburg, Russia
Dec. 15, 1881		Head, Harold Ellershaw, 24, Auriol-road, West Kensington, W.
Mar. 16, 1876		Head, Jeremiah, Portland-terrace, Redcar, Yorkshire
June 21, 1883		Heap, Hargreaves, Rev., B.Sc., The Grammar School, Rotherham, Yorks
Dec. 3, 1891		Heath, John William, 33, Upper Gloucester-place, W.
Dec. 18, 1854		Heaton, Charles W., Charing-cross Hospital, W.C.; and 44, Woodstock-road, Bedford-park, W.
Mar. 3, 1887		Hedley, T. Albert, 41, Jean Baptiste-street, Montreal, Canada
Nov. 2, 1876		Hehner, Otto, 11, Billiter-square, E.C.
Dec. 4, 1890		Heller, William M., King's College School, Strand, W.C.
June 3, 1875		||Hellon, Robert, Ph.D., Seascale, viâ Carnforth
Jan. 18, 1872		Helm, Henry James, Simonstone, Hammelton-road, Bromley, Kent
Dec. 5, 1889		Helbing, H. B., 63, Queen Victoria-street, E.C.
Feb. 5, 1885	Trans	Henderson, George G., M.A., D.Sc., F.I.C., the Technical College, 204, George-street, Glasgow
Feb. 18, 1892		Hendrick, James, Laurel Cottage, Watermoor, Cirencester
April 19, 1883		Henning, E. C., The Bow Brewery, Bow, E.
Feb. 21, 1853		Hepburn, J. G., LL.B., Dartford, Kent
June 18, 1885		Hepworth, Thomas Cradock, 45, St. Augustine's-road, Camden-square, N.W.
Feb. 16, 1871		Herman, Douglas, Eccleston-park, Prescot
June 15, 1876	Trans	Heron, John, care of Messrs. Garton, Hill, & Co., Southampton Wharf, Battersea, S.W.
May 5, 1892	Trans.	Hewett, John Theodore, St. John's College, Cambridge
Feb. 18, 1892		Hewlett, John C., 40, Charlotte-street, Great Eastern-street, London, E.C.
June 21, 1883	Trans.	||Heycock, Charles T., M.A., 24, Fitzwilliam-street, Cambridge
Feb. 16, 1882		Heyes, J. F., Rev., M.A. Oxon., F.R.G.S., Magdalen College, and 32, Hempstall-road, West Hampstead, N.W.
April 1, 1875		Heywood, Charles A., Ivy Bank, Cardiff
Dec. 1, 1864		Heywood, Henry, Cardiff
Dec. 1, 1887		||Heywood, J. Garnett, 127, Sutherland-avenue, Maida Vale, W.
Feb. 6, 1890		Heywood, Joseph H., 23, Holland-street, Rochdale
April 3, 1848		Heywood, J. S. C., 19, Inverness-terrace, Kensington-gardens, W.
June 1, 1876	Trans	Hibbert, Walter, 14, Goldhurst-terrace, South Hampstead, N.W.
Feb. 21, 1889		Hickey, John Joseph, Heathfield, Seymour-grove, Old Trafford
Mar. 17, 1881		||Hiddingh, Michael, Newlands, near Capetown
May 7, 1891		Hiepe, William L., Ph.D., The Laboratory, Kilvert's Buildings, Withy Grove, Manchester

Date of Election.		
Jan. 20, 1870		Higgins, Clement, M.A., 5, Trebovir-road, Earl's Court-road, W.
March 16, 1882		‖Hill, Alexander, Campanas, 15, Cordova, Spain
Dec. 16, 1858		Hill, Alfred, M.D., F.I.C., Medical Officer of Health, The Council House, Birmingham
Feb. 7, 1853		Hills, Frank C., Chemical Works, Deptford, S.E.
Mar. 5, 1892		Hills, Harold F. 149, Bow road, London, E.
May 15, 1873		‖Hills, Walter, 225, Oxford-street, W.
Feb. 7, 1878		Hind, H. R., 67, High-street, Clapham, S.W.
May 5, 1892		Hinnell, Henry Leonard, Knowsley-chambers, Bolton
Jan. 20, 1870		Hislop, G. R., Gasworks, Blackstoun-road, Paisley
Nov. 18, 1886		Hislop, Lawrence, Dalmeny, Saltney, Chester
June 21, 1883		‖Hobbs, Bedo, The Brewery, High-street, Maidenhead
Dec. 18, 1884		Hodges, Herbert J., Stoneleigh, Worple-road, Wimbledon
April 15, 1844	Trans.	Hodges, John F., Prof., M.D., F.I.C., J.P., Queen's College, Belfast, and Sandringham, Malone-road, Belfast
Nov. 16, 1882	Trans.	‖Hodgkin, John, F.L.S., F.I.C., 12, Dynevor-road, Richmond-on-Thames
Dec. 18, 1879	Trans.	Hodgkinson, W. R. Eaton, Prof., Ph.D., F.R.S.E., 8, Park-villas, Blackheath, S.E.
April 15, 1886		Hodgson, Christopher, High House, Eppleby, Darlington
April 17, 1873		‖Hodgson, H. Tylston, Harpenden, Herts
Dec. 1, 1887		Hogben, Walter, 15, Pilrig-street, Edinburgh
May 7, 1885		Hogg, Edward Grindle, 1, Southwick-street, Hyde Park-square, W.
Mar. 1, 1883		Hogg, W. Douglas, M.D., 62, Champs Elysées, Paris
April 17, 1890		Holburn, A., Cowan, B.Sc., 10, West-garden-street, Glasgow
June 11, 1876		Holcroft, Harold, M.A., 56, Compton-road, Wolverhampton
Dec. 3, 1885		Holgate, Thomas, 12, Hyde Park-road, Halifax
Mar. 16, 1876		Holland, Philip, 27, Albert road, Southport
Dec. 3, 1891		Holliday, John, The Gas Works, Scarboro'
Dec. 2, 1880		Holliday, Robert, Huddersfield
June 18, 1891		Holloman, Frederick R., 54, Russell-road, Custom House, E.
Mar. 4, 1886		Holloway, George Thomas, 57 and 58, Chancery lane, W.C.
Dec. 2, 1886		Holt, George Crompton, Soap Manufacturers, Albion Works, Congleton, Cheshire
May 4, 1865		Holzmann, M., Ph.D., Marlborough-house, S.W.
Feb. 7, 1878		Hooker, A. H., Board of Health, Cairo, Egypt
Mar. 1, 1883		‖Hooper, David, Ootacamund, Madras Presidency, India
May 17, 1888		Hooper, E. Grant, 24, Bloomfield-terrace, Buckingham Palace-road, S.W.
Feb. 19, 1891		‖Hooper, Ernest F., c/o Messrs. Burt, Boulton, and Haywood, Prince Regent's Wharf, Victoria Docks, E.
May 7, 1885		Hope, Charles Frederick, Prof. M.R.A.C., 34, Grosvenor-terrace, York

Date of Election.		
Feb. 3, 1887		Hori, E., Tokyo Hygiene Laboratory, Kauda Ku, Tokyo, Japan
Dec. 15, 1892		Horsfall, John, Plantation House, Cloughfold, Lancashire
Mar. 4, 1886		‖Hoskins, Arthur Percy, Corporation Gas Works, Belfast
Dec. 7, 1882		Hotblack, Herbert A., Cannon Brewery, Brighton
Feb. 16, 1871		Houlder, W. W., 10, Ossulton-villas, Southall-green, Southall
Mar. 17, 1887	Proc.	Houlding, William, B.Sc., Stanley House, Anfield, Liverpool
Dec. 7, 1882		‖Howard, Alfred G., The Green, Tottenham, and Stratford, E.
Feb. 18, 1869		Howard, Alfred K., Flint, North Wales
Nov. 3, 1870	Trans.	‖Howard, David, Rectory Manor, Walthamstow
April 21, 1887		‖Howard, D. Lloyd, jun., Rectory Manor, Walthamstow
Dec. 18, 1879		Howard, John, 22, Ashby-road, Canonbury
Mar. 4, 1875		Howard, Thomas, 50, Ellington-street, Liverpool-road, N.
June 20, 1889		Howard, George William, 49, Pier-road, Erith, Kent
Dec. 7, 1882		Howe, J. Lewis, M.D., Ph.D., Scientist to the Polytechnic Society, Louisville, Kentucky, U.S.A.
Feb. 19, 1880		Howell, Reginald, 95A, Southwark-street, S.E.
Jan. 20, 1876		Howie, W. L., Cornbrook House, Clarendon-road, Eccles, Lancashire
May 20, 1886		Howson, George W. S., Uppingham School, Rutland
April 4, 1889		Hoyle, Richard Ashworth, 11, Market-square, Lytham, Lancs.
April 4, 1889		Hoyles, Henry Richardson, care of Messrs. Treacher and Co., Byculla, Bombay
Mar. 2, 1871		‖Hudleston, W. H., M.A., F.G.S., 8, Stanhope Gardens, South Kensington, S.W.
Feb. 21, 1878		Hudson, William, B.Sc. (Lond.), The Lilies, Twickenham
Feb 23, 1841		*Hughes, F. R., Bo'ness, Linlithgowshire
June 17, 1880		Hughes, George Henry, Analytical Laboratory, Barbadoes, West Indies; and 79, Mark-lane, E C.
Dec. 17, 1868		Hughes, John, Analytical Laboratory, 79, Mark lane, E.C.
May 17, 1888		Hughes, John, 3, West-street, Finsbury-circus, E.C.
Dec. 5, 1889	Trans.	Hughes, Robert Edward, B.Sc. (Lond.), Sunningdale; 8, Gilridge-road, Eastbourne; The College, Eastbourne
June 4, 1885		Hughes, T. Vaughan, Greenfield Mills, Holywell, North Wales
Nov. 16, 1882		Hughes, Thomas, Borough Analyst, West Wharf, Cardiff
Nov. 20, 1884		Hulme, James, Mount House, Hollingworth, Hadfield, near Manchester
April 19, 1883		Humphrys, Norton H., 4, The Paragon, Wilton-road, Salisbury
Dec. 18, 1879	Trans.	Hummel, J. J., 7, Moorfield-villas, Woodsley-road, Leeds
Mar. 18, 1869		Hunt, Charles, Birmingham Gas Light Works, Windsor-street, Birmingham
Feb. 1, 1883	Trans.	Hunter, John, Minto House, Medical School, Edinburgh
Dec. 3, 1885		Hunter, Matthew, M.A. Oxon, Rangoon College, Lower Burmah
April 4, 1878		Huntington, A. K., Prof., Metallurgical Laboratory, King's College, W.C.

Date of Election.		
Dec. 3, 1885		Hurst, George H., 22, Blackfriars-street, Salford
Dec. 3, 1885		Husband, John Cecil, 57, George-street, Cheetham, Manchester
Mar. 21, 1861		Huskisson, H. O., 77, Swinton-street, Gray's-inn-road, W.C.
Feb. 6, 1890	Trans.	Hutchinson, Arthur, Pembroke College, Cambridge, M.A., Ph.D.
Jan. 17, 1884		Hutchinson, C. Clark, 193, Romford-road, Stratford, E.
Feb. 7, 1867		||Ince, Joseph, 11, St. Stephen's-avenue, Shepherd's-bush, W.
April 4, 1889	Proc.	Ingle, Herbert, Poole, near Leeds
Nov. 15, 1888		Ingram, A. C., Mounsey, 5, Buchanan-terrace, Paisley
Jan. 19, 1882		Irons, Herbert E. J., Chatham, New Brunswick, Canada, and Hapenden, St. Albans
Dec. 7, 1871		Irvine, Robert, Royston, Granton, near Edinburgh
Dec. 6, 1883		||Irwin, Wilfred, The Grange, Polygon-road, Higher Crumpsall, Manchester
Dec. 15, 1892		||Isaac, John F. V., 18, Montserrat-road, Putney, S.W.
Feb. 16, 1882		Isherwood, Thomas, University School, Southport
Dec. 16, 1875		Ivey, W. Edward, Canterbury College, School of Agriculture, Lincoln, New Zealand
Nov. 19, 1885		Ivatt, Albert, B.A., 11, Willis-road, Cambridge
Feb. 1, 1883		Jackson, Alfred H., B.Sc., Prof., c/o Wm. Bowen and Co., Collins-street, W., Melbourne, Australia
Dec. 7, 1882		Jackson, Edward, 27, Beaufort-road, Edgbaston, Birmingham
Dec. 5, 1889		||Jackson, Eric H., B.Sc., 61, Portland-street, Manchester
Dec. 18, 1884	Trans.	Jackson, Herbert, 3, Amyand Park Gardens, East Twickenham
Dec. 4, 1890		Jackson, John Richard, 51, Abbotsford-place, Glasgow
Dec. 15, 1881		Jackson, Wm., F.G.S., 61, Beaconsfield-terrace, Northampton
Mar. 6, 1890		Jackson, John Charles, M.R.C.S., L.R.C.P., 2, Fulham Park-villas, Fulham, S.W.
Dec. 6, 1883		Jackson, Robert, 18, Harrington-street, Dublin
Dec. 15, 1884		||Jackson, R. Valentine, Ph.D., care of the Scotch and Irish Oxygen Company, Polmadie, Glasgow
Dec. 6, 1888		Jackson, Urban Arthur, 43, Great Ducie-street, Strange-ways, Manchester
June 16, 1887		||Jadhava, K. B., Baroda, Bombay Presidency, India
May 16, 1878		Jago, William, F.I.C., 32, Clarendon-villas, Brighton
Feb. 18, 1888	Trans.	||James, Christopher, care of Elliott's Metal Company, Pembrey Copper Works, R.S.O., Bury Port, South Wales
Feb. 17, 1881	Trans.	James, J. William, Ph.D., 29, Redcliffe-street, Bristol
Feb. 7, 1878		Jamieson, Alexander, 5, St. Mark's-crescent, Regent's Park, N.W.
Feb. 6, 1879	Trans.	†||Japp, F. R., M.A., LL.D., Ph.D., F.R.S., University, Aberdeen
Nov. 16, 1882		J'armay, Gustav, Winnington-park, Northwich, Cheshire
Feb. 19, 1891		Jenkins, Henry Charles, 17, St. Julian's-road, Kilburn, N.W.

† Longstaff Medallist, 1891.

Date of Election.		
Nov. 20, 1890		Jenkins, Wallis, 9, Arnold-street, Aulaby-street, Hull
May 5, 1887		‖Jenkins, John H. B., Chemical Laboratory, G. E. Ry. Works, Stratford, E.
Feb. 1, 1883		Jenner, Thomas, Brewery House, Taunton
April 17, 1879		Jewson, Francis A. B., 11, Kenwyn-road, High-street, Clapham
Feb. 4, 1875		‖Johnson, David, F.G.S., F.R.M.S., 3, Victoria-road, Clapham, S.W.
Dec. 18, 1884		‖Johnson, Frank, Thariss, Huelva, Spain
Feb. 21, 1878	Trans.	Johnson, George Stillingfleet, 11, Savile-row, W.
Feb. 1, 1883		Johnson, James Edward, 40, Edmiston-road, Stratford, E.
May 16, 1872		Johnson, John Grove, 41, Cross-street, Finsbury, E.C.
May 20, 1886		Johnson, J. T., Oakham School, Rutland
Dec. 6, 1883		Johnson, Samuel, 174, Queen's-road, Everton, Liverpool
May 10, 1866		Johnson, Samuel H., Warren Hill House, Loughton, Essex
Dec. 18, 1884		Johnstone, James D., Moss Bank, Fettercairn, Lawrence-kirk, N.B.
April 17, 1879		Johnstone, William, 13, Fish-street-hill, Eastcheap, E.C.
Dec. 15, 1892		Johnston, William George, 4, Hilgrove-road, Finchley-road, South Hampstead, N.W.
May 20, 1886		Jones, A. Wentworth, B.A., 15, Cambridge-gardens, Folkstone
April 6, 1871	Trans.	Jones, E. W. T., Pennfields, Wolverhampton; and 10, Victoria-street, Wolverhampton
Dec. 4, 1873	Trans.	Jones, Francis, F.R.S.E., Beaufort House, Alexandra, Park, Manchester
May 4, 1876	Trans.	‖Jones, H. Chapman, Royal College of Science, South Kensington, S.W.
May 16, 1878		Jones, Henry William, Grosvenor-street, Coventry
Dec. 15, 1856		Jones, Hodgson, Meadowville, North-road, Highgate, N.
May 15, 1890		Jones, John Archyll, 26, Baker-street, Middlesborough
Feb. 19, 1891		Jones, M. William, 343, Aspen-terrace, Church, Lancashire
Feb. 18, 1892		Jones, Lionel Manfred, Royal College of Science, South Kensington
May 7, 1891		Joseland, Walter Herbert, Mitchell's Wood Cottage, near Chesterton, Staffordshire
Feb. 21, 1891		Jowett, William Hall, Blackburn
Dec. 16, 1886	Trans.	Kawakita, Michitada, Engineering College, Tokyo, Japan
Feb. 17, 1881	Trans.	Kay, William E., Gowausbank, Busby, near Glasgow
June 2, 1856		Kay, William, Rev., B.A., 114, Mount-street, Grosvenor-square, W.
Dec. 5, 1889		Kaye, James R., M.D., Medical Officer of Health, Town Hall, Huddersfield
Dec. 20, 1883		‖Keeling, Frank, Dapdune Cottage, Guildford
Dec. 7, 1882		Keen, Austin, Sunny Bank Villas, Edgerton, Huddersfield

Date of Election.		
Mar. 19, 1874		Kellner, William, Ph.D., Chemical Department, Royal Arsenal Woolwich, S.E.
April 1867		||Kemp, David Skinner, Missenden Villa, Coverdale-road, Shepherd's Bush, W.
May 4, 1882		Kemp, William Joel, Mountfield, Hawkhurst
Dec. 18, 1884		Kendall, George Frederic, B.A., The Hollies, Stratford-upon-Avon
Dec. 17, 1874		Kendall, James Alfred, Lonesome Chemical Works, Streatham Common, S.W.
Dec. 5, 1889		Kenwood, Henry R., M.B., C.M. (Edin.), L.R.C.P. (Lond.), 189, Adelaide-road, N.W.
Dec. 20, 1883		Kerry, William H. R., Wheatlands, Windermere
April 15, 1875		Keyworth, George Alexander, St. Hilary, Hastings
Dec. 7, 1882		Kilner, Frederick James, Royal Infirmary, Bristol
April 15, 1886		Kilpatrick, Charles, Laboratory, Health Office, Holt Town Depôt, Manchester
Jan. 17, 1884		Kilpatrick, W Stirling, 4, Annfield-place, Glasgow
Nov. 20, 1890		Killop, John M., Puloh Brain Smelting Works, Singapore
Feb. 15, 1872	Trans.	||Kinch, Edward, Royal Agricultural College, Cirencester
Feb. 17, 1881	Trans.	King, Alfred John, Ingersley Vale, Bollington, near Macclesfield
Mar. 15, 1888		King, C. Millard, 21, Godliman-street, E C.
Dec. 7, 1876		King, J. F., Laboratory of City Analyst, Edinburgh
Dec. 5, 1872	Trans.	Kingzett, Charles T., Trevena, Amhurst-park, London, N.
Mar. 1, 1877		Kininmont, Alex., 21, Abbotsford-place, Glasgow
May 7, 1891	Trans.	||Kipping, F. Stanley, Ph.D., D.Sc. (Lond.), 7, Melborne-grove, South Kensington
Dec. 2, 1886		Kirby, Herbert E., 307, High Holborn, W.C.
May 15, 1890		Kirk, Oliver, Blaemire, Greysouthen, viâ Carlisle
Feb. 2, 1888	Trans.	Kirkland, J. Booth, Princes-hill, Carlton, Melbourne, Victoria
May 17, 1888		Kirkman, Henry James, Landore, Alkali Works, Swansea
June 19, 1873		||Kitchin, Archibald, F.I.C., Scragill House, Whitehaven
May 16, 1889		Kitchin, John, The Middlesex Hospital, W.C.
Dec. 6, 1888		||Knaggs, Alfred Battye, Springfield Mill, Morley, near Leeds
Mar. 5, 1885		Knight, Alfred Henry, 34, Bentley-road, Prince's-park, Liverpool
June 20, 1889		Knight, Frederick Charles, Boston and Colorado Smelting Company, Argo, Colorado, U.S.A.
May 16, 1878		Knights, James West, County Laboratory, Cambridge
Dec. 5, 1889		Knott, Frederick Thomas, The Laurels, Eltham-road, Lee, S.E.
June 18, 1891		Knowles, John, Messrs. Bowman, Thompson and Co., Lostock, Gralam, near Northwich
Dec. 18, 1879		Knowles, Joshua, Stormer-hill, Tottington, Bury
June 16, 1864		Knox, G. W., B.Sc., Hoole's-chambers, Bank-street, Sheffield
Feb. 6 1873		Koch, Walter Edward, M.A., F.G.S., Sharpsburg, Allegheny County, Pennsylvania

Date of Election.		
Nov. 17, 1887		Koga, Yoshimasa, The Imperial Mint, Osaka. Japan
June 17, 1886		Kohn, Charlers A., Ph.D., B.Sc., Chemical Laboratory, University College, Brownlow-street, Liverpool
June 8, 1885		Koningh, Leonard de, 325, Kennington-road, S.E.
Feb. 17, 1859	Trans.	Kynaston, Josiah W., Chemical Laboratory, 3, Oak-terrace, Beech-street, Liverpool
Feb. 3, 1859		‖Lackersteen, Mark Henry, M.D., M.R.C.P. Lond., M.R.C.S. Eng., F.L.S.. Medical School, and 163, State-street, Chicago, Illinois, U.S.A.
Feb. 16, 1888		Lafosse, Charles R., Abbotsford, Wildercombe Park, Ilfracombe
Dec. 15, 1892		‖Lamb, Thornton Charles, The Polygon, Ardwick, Manchester
Jan. 18, 1877		Lancaster, William James, F.R.A.S., F R.G.S., F.R.M.S., The Hollies, Handsworth Wood, Birmingham
Mar. 4, 1886		Lang, William, jun., Cross Park, Partick, N.B.
June 18, 1885		Langer, Charles, Ph.D., 5, Redesdale-terrace, South Hampstead
May 7, 1891		‖Langham, Rev. E. Norman, M.A. (Cantab), F.I.C., Head Master, Rastrick Grammar School, Brighouse
June 21, 1877	Trans.	Lapraik, William, Ph.D., F.I.C., Chemical Laboratory, St. Bartholomew's Hospital, E.C.
June 21, 1883		Lascelles, B. P., B.A., Harrow
April 15, 1880		Last, Frank B., Laboratory, 78, Mansell-terrace, Swansea
May 7, 1891		Lauder, Alexander, University College of North Wales, Bangor
Feb. 21, 1889		Lauer, Wm. Eggleston, 657 and 659, Broadway, New York City
Mar. 4, 1886	Trans	Laurie, Arthur P., 49, Beaumont-square, Mile End, E.
Nov. 16, 1876		‖Law, Channell, Ilsham Dene, Torquay
Feb. 6, 1890		Law, Robert, F.R.M.S., The Royal Mint, Melbourne
June 17, 1850	Trans.	‖Lawes, Sir John Bennet, F.R.S., Rothamsted, near St. Albans
June 17, 1880		Lawrance, Henry Awbrey, 28, Grosvenor-road, Gunnersbury, W.
Jan. 19, 1882		Laws, J. Parry, 3. Fyfield-road, Oxford
Feb. 2, 1888	Trans.	‖Lawson, Thomas Atkinson, Ph.D., B.Sc., 15, Alexandra-road, N.W.
April 17, 1890		‖Laycock, William Frederick, Ph.D., 2, Park-street, Dewsbury
April 17, 1890		Lea, A. Sheridan, Caius College, Cambridge
Dec. 16, 1886		‖Leach, Walter, 27, St. Andrew's-place, Bradford
April 4, 1889		Leaper, Clement Joseph, 19, Belvidere-road, Taunton, Somerset
Feb. 2, 1888		Lease, Frank E., Melapi Estate, Sandakan, British North Borneo
Dec. 3, 1891		Leather, J. Walter, Ph. D., care of Land Revenue and Agricultural Department. Government of India, Calcutta
Dec. 5, 1889		Ledingham, L. Napier, Longley Farm, Longley, near Sheffield
Dec. 6, 1883		Lee. Herbert C., The New Westminster Brewery Company, Earl-street, Horseferry-road, S.W.
Feb. 1, 1883		Lee, Robert Brewer, B.Sc., B.A., 6, Warwick-street, Kensington, W.

Date of Election.		
June 18, 1891		Leeds, Frank H., 26, East Bank, Stamford-hill, N.
Mar. 1, 1883		Leeming, T. H., Burneston House, Barking-road, Plaistow, Essex
Feb. 6, 1873		Lees, Charles, Grange College, Leominster
Dec. 1, 1887		Lees, Samuel, jun., Park Bridge, Ashton-under-Lyne
Dec. 3, 1891		Leffler, Rudolf, 21, Havelock-street, Sheffield
May 16, 1889		‖Legg, John Edmund, M.A., F.I.C., Weymouth College, Ing Ravan, Carlton-road, Weymouth
Dec. 18, 1879		Leibius, Adolph, Ph.D., Royal Mint, Sydney
May 7, 1891		Leicester, James, 3, Queen's Parade, Brandon Hill, Bristol
Jan. 17, 1889		Leigh, Cecil, Birmingham Small Arms and Metal Company, Adderley Park Rolling Mills, Birmingham
Dec. 1, 1887		Lennox, David, M.D., 144, Nethergate, Dundee
Dec. 3, 1891		Lennox, Robert N., 3, Inverness-terrace, Fulham, S.W.
Jan. 17, 1889		Lenox, Lionel R., Ph.B., Leland Stamford University, Palscelto, California
June 17, 1886		Leon, John Temple, 38, Portland-place, W.
Jan. 19, 1882		Lescher, Frank Harwood, 60, Bartholomew-close, E.C.
April 17, 1890		Lescher, Herman, 61, Egerton-gardens, South Kensington
Feb. 6, 1879	Trans.	Letts, Edmund Albert, Ph.D., Queen's College, Belfast
April 19, 1883		Levy, Lawrence, 3, Yew Tree Avenue, Carrington, Notts.
Mar. 15, 1888	Trans.	Lewes, Vivian B., 19, Park-row, Greenwich, S.E.
Mar. 20, 1884		Lewis, A. E., 94, Tritonville-road, Sandymount, Dublin
Nov. 18, 1869	Trans.	‖Lewis, W. J., Mineralogical Museum, Cambridge
Feb. 16, 1888	Trans.	Lewkowitsch, Julius, Ph.D., Whitehall Soap Works, Leeds
Feb. 21, 1878		Lichtenstein, T., Chemical Works, Silvertown, E.
April 15, 1880		Liepmann, Henry, Ph.D., Chemical Laboratory, 40, Lexham-gardens
June 21, 1866		Lightbown, J. H., 13, Victoria-crescent, Eccles, near Manchester
May 5, 1892		Lindley, Hubert Edward, 13, St. Bartholomew-road, Camden-road, London, N.
Mar. 5, 1874		Linford, J. S., 16, Gladstone-street, Aulaby-road, Hull
April 15, 1886	Trans.	Ling, Arthur R., Carlton Villas, Lambton-road, Cottenham Park, Wimbledon
Feb. 7, 1878		Linnell, Arthur, New Cransley Iron and Steel Co., Kettering
May 5, 1892		Lintern, Albert A., B.Sc., Kendrick School, Reading
Nov. 21, 1853		‖Liveing, G. D., M.A., Cambridge
Nov. 7, 1872	Trans.	‖Liversidge, Archibald, F.R.S., Prof., University, Sydney, New South Wales
June 21, 1883		Livingston, W. J., London County Council, Spring-gardens, S.W.
Feb. 19, 1880		‖Lloyd, Alfred, The Dome, Bognor, Sussex
Feb. 3, 1876	Trans.	Lloyd, F. J., Agricultural Laboratory, 4, Lombard-court, E.C.
Jan. 17, 1889		Lloyd, George, 10, Halliford-street, Essex-road, N.
Feb. 16, 1871		Lockyer, William John, 7, St. Julian's Farm-road, West Norwood, S.E.

Date of Election.		
Mar. 20, 1884		London, J. Edward, M.D., 62, Main-street, George Town, Demerara
April 18, 1872		‖Longstaff, George Blundell, M.A., M.B. Oxon., M.R.C.P., Highlands, Putney Heath, S.W.
Dec. 15, 1881		‖Looker, Percy Stratford
Feb. 20, 1873		Loram, H. Y., 19, Hillside-road, Stamford-hill, N.
Feb. 7, 1878	Trans.	‖Louis, D. A., 77, Shirland-gardens, Maida Vale, W.
May 4, 1882		Love, Edward G., Ph.D., 69, East 54th-street, New York, U.S.A.
June 15, 1882		‖Lovibond, Thomas Watson, F.I.C., The Tyne Brewery, Newcastle-on-Tyne
Dec. 18, 1884		Low, Charles William, M.B., Stowmarket
Dec. 15, 1856		‖Lowe, Charles, Summerfield House, Reddish, near Stockport
Feb. 21, 1878		‖Lowe, Walter Bezant, M.A., Stranraer School, Wickham, near Fareham. Hants
Feb. 3, 1876		Lowe, W. F., Cambrian View, Chester
Dec. 6, 1888		Lowman, Oscar A. B., Ph.D., 424, Brush-street, Detroit, Michigan, U.S.A.
Feb. 18, 1892		Luckett, A. H., The Palace School, Enfield, Middlesex
Dec. 3, 1891		Ludlow, Lionel, The Cape Copper Co., O'okiep, Namaqua-land, Cape of Good Hope
Feb. 15, 1877	Trans.	Luff, A. P., M.D., B.Sc. (Lond.), M.R.C.P., 47, Weymouth-street, Cavendish-square, W.
Mar. 6, 1890		Lumsden, John S., B.Sc., 5, Paradise-road, Dundee
Dec. 5, 1867	Trans	Lunge, Dr. George, Polytechnicum, Zürich, Switzerland
Dec. 4, 1890	Trans.	Lunt, Joseph, B.Sc., 5, South-view, Eccleston-road, Ealing Dean, W.
Dec. 5, 1872	Trans.	‖Lupton, Sydney, Grove Cottage, Roundhay, Leeds
May 1, 1873		Lyon, J. B., Brigade Surgeon, East India, U. S. Club, 16, St. James's-square, S.W.
Feb. 19, 1874		Lyon, J. G., The Aire Tar Works, Knottingley, Yorks
Nov. 18, 1886		Lyons, Albert Brown, A.M., M.D., Honolulu, Hawaiian Islands
Feb. 3, 1859	Trans.	‖Lyte, F. Maxwell, F.I.C., Assoc. I.C.E., 60, Finborough road, Kensington, S.W.

Feb. 16, 1888		Maben, Thomas, 5, Oliver-place, Hawick
June 20, 1878		Macadam, C. T., The Lake, Snaresbrook, Essex
April 21, 1864		‖Mactear, James, F.R.S.E., 2, Victoria-mansions, Westminster, S.W.
Feb. 21, 1853	Trans.	Macadam, Stevenson, Ph.D., F.R.S.E., Surgeons' Hall, Edinburgh
Feb. 2, 1888		‖Macadam, Stevenson, J.C.G., jun., Surgeons' Hall, Edinburgh
April 4, 1878		Macadam, W. Ivison, F.R.S.E., Surgeons' Hall, Edinburgh
Dec. 2, 1886		Macan, Hugh O'Donaghan, Imperial-buildings, Ludgate-circus, E.C.

Date of Election.		
April 17, 1890		||MacArthur, J. Stewart, 46, Melville-street, Pollokshields, Glasgow
May 7, 1891		MacDonald, William, Chinese Polytechnic Institution, Shanghai
Mar. 4, 1886		MacEwen, Peter, 4, Gresley-road, Hornsey-lane, N.
June 18, 1891		Macfie, R. A. Scott, B.A. (Cantab), 68, Rodney-street, Liverpool
Dec. 2, 1880		Macfarlane, James A., care of Mr. Robert Stevenson, 917, Vender-street, Vancouver City, British Columbia
Mar. 6, 1890		Macintyre, Alfred E., St. John's, N.B., Canada
June 17, 1875		Mac Ivor, R. W. Emerson. c/o Hannay's Patents Company, 67, Great Clyde-street, Glasgow
Dec. 2, 1887		Mackay, Angus, Technical College, Sydney, N.S.W.
Dec. 2, 1886		Mackay, J. B., Lillie Prof. A.K.C.L., Director of the School of Mines, Sandhurst, Victoria, Australia
Dec. 4, 1890		Mackean, William, 14, Palmer-street, Westminster, S.W.
Dec. 3, 1874		Mackenzie, D. C., 106, Leadenhall-street, E.C.
Feb. 18, 1892		Mackenzie, William Cossar, Tewfikieh College of Agriculture, Ghizeh, Cairo
Mar. 5, 1885		Mackey, Wm. McD., Victoria-chambers, South-parade, Leeds
Jan. 15, 1844		Maclagan, Douglas, Sir, M.D., F.R.S.E., University of Edinburgh, and 28, Heriot-row, Edinburgh
Jan. 17, 1889		MacLeroy, Arthur Lloyd, M.A. (Oxon), L.S.A., 12, George-street-Bathwick Hill, Bath
April 17, 1879		Macmillan, J. L., 1, Mangoe-lane, Calcutta
Feb. 17, 1881		MacMunn, Charles A., M.A., M.D., F.R.M.S., Oakleigh, Wolverhampton
Feb. 1, 1880		Macnab, William, 14, Great Smith-street, Westminster, S.W.
June 4, 1885		Macnair, Duncan Scott, Ph.D., B.Sc., People's Palace, Technical Schools, London, E., and Hampden House, Phœnix-street, N.W.
April 19, 1888		MacSwiney, E., 13, North Main-street, Cork
Feb. 6, 1890		Mactaggart, James Guthrie, care of Messrs. Boarhead and Co., Singapore
May 1, 1862	Trans.	Madan, H. G., Bearland House, Gloucester
June 21, 1888	Trans.	Maiden, Joseph Henry, Curator, Technological Museum, Sydney, N.S.W.
May 5, 1892		Major, George Harry, Higher Grade Boys' School, Llanelly
May 7, 1885		||Mallet, F. R., 18, The Common, Ealing, W.
Dec. 17, 1857	Trans.	Mallet, J. W., Ph.D., M.D., F.R.S., University of Virginia, Albemarle, Co. Va., U.S.N.A.
Feb. 4, 1858		||Manning, F. A., 18, Billiter-street, E.C.
Feb. 7, 1853	Trans.	Marcet, W., M.D., F.R.S., Flowermead, Wimbledon Park, S.W.
June 16, 1881		||Marsh, Charles W., Ph.D., 126, Liberty-street, New York, U.S.A.
Feb. 15, 1883	Trans.	Marsh, J. E., University Museum, Oxford

Date of Election.		
Feb. 6, 1890	Trans.	Marshall, Hugh, D.Sc., F.R.S.E., Chemistry Department, University of Edinburgh
Dec. 3, 1891		Marshall, John Willis, 8, Fairfield-terrace, West Park-street, Dewsbury
Feb. 19, 1891		Marshall, Reginald Tom, 25, Lancaster-park, Richmond, Surrey
Nov. 20, 1890		Marshall, T. Rhymer, D.Sc., University College, Cardiff
Dec. 6, 1888	Trans.	Marshall, William, c/o D. G. Rose, Esq., Samarang, Java
June 16, 1887		Marshall, William, F.I.C., 15, West-street, Rochdale
Nov. 19, 1885		Martin, Major Gerald Ward, F.R.G.S., Assay Office, Imperial Mint, Bombay
Dec. 6, 1883		Martin, W. H., 183, King's-road, Chelsea, S.W.
Feb. 19, 1891		Martin, William Morley, 203–205, Old Christchurch-road, Bournemouth
April 7, 1870		Martindale, William, 10, New Cavendish-street, W.
June 1, 1871		‖Martineau, George, 21, Mincing-lane, E.C.
Dec. 1 1887		‖Martineau, Sydney, South-road, Clapham-park, S.W.
June 2, 1851	Trans.	Maskelyne, Nevil Story, F.R.S., M.P., Salthrop, Wroughton, Wilts
Mar. 2, 1871		Mason, Alfred Henry, F.R.M.S., 46, Jewin-street, London, E.C.
Nov. 4, 1858		‖Mason, James, Eynsham-hall, near Witney, Oxon
Dec. 2, 1880		Mason, William Brandwood, 117, Derby-street, Bolton
Dec. 5, 1889		Mason, James Braik, 9, Balgay Avenue, Dundee
Feb. 6, 1890		Mason, Francis H., 25, Margarette-terrace, Oakley-street, S.W.
Dec. 5, 1889		Mason, G. B., 12, Croombridge-road, South Hackney
Jan. 19, 1882	Trans.	Masson, D. Orme, M.A., B.Sc., The University, Melbourne, Australia
Dec. 4, 1873		Masters, William, Sub-Deputy Opium Agent, Gya, Bengal, India, and 82, Oxford-gardens, Notting Hill, W.
June 15, 1876	Trans.	‖Matthews, C. G., The Laboratory, Bridge Chambers, Burton-on-Trent
June 17, 1880	Trans.	Matthews, Francis Edward, Ph.D., Royal Indian Engineering College, Cooper's Hill, Staines
Dec. 1, 1887		Matthews, Wm. Edward, Prof., The Stawell School of Mines, Stawell, Victoria, Australia
Jan. 17, 1884		‖Matthey, Edward, 78, Hatton-garden, E.C.
May 3, 1870		Matthey, George, F.R.S., 78, Hatton-garden, E.C.
Dec. 7, 1865		‖Maxwell, Theodore, B.A., M.D. Camb., B.Sc. Lond., 29, Woolwich-common, S.E.
Dec. 5, 1867		Maybury, Charles Walter, 141, Church-street, Eccles, Lancashire
June 7, 1888		Mayhew, E. W. A. Augustine, Freemantle, Western Australia
Feb. 3, 1887		McArthur, J. F., Belgrave-crescent, Eccles, near Manchester
Dec. 1, 1887		‖McArthur, John, F.R.S.E., 196, Trinity-road, Wandsworth Common, S.W.
Feb. 2, 1888		McBretney, Edmund G., 24, Eastfield-road, Castleford, York
Feb. 21, 1889		McCalman, George, India-street West, Glasgow

Date of Election.		
Feb. 6, 1890		McConnell, Arthur H., 35, Bernard-street, Russell-square, W.C.
Feb. 4, 1875		‖McCowan, William, F.I.C., The Brewery, Reading
Nov. 20, 1890		‖McCubbin, William A., Mill Bank House, West Derby, Liverpool
Dec. 17, 1857		McDougall, Alexr.,17, Belmont-street, Southport
Dec. 17, 1874		McDougall, John, Clifton House, Greenwich-park, S.E.
Feb. 18, 1892		McFall, J. E. Whitley, Bankfield-road, West Derby, Liverpool
Mar. 3, 1887	Trans.	McGowan, George, Ph.D., Harris Institute, Preston
May 5, 1892		McKerrow, William James, D.Sc., Chemical Department, Royal Naval College, Greenwich, S.E.
Feb. 6, 1868	Trans.	McLeod, Herbert, F.R.S., Indian Civil Engineering College, Cooper's Hill, Staines
Feb. 17, 1881		McMillan, Walter George, Chemical Department, Shell Factory, Cossipore, Calcutta, India
April 4, 1889	Trans.	‖McMurtry, George Cannon, Wallaroo Smelting Works, Wallaroo, S. Australia
Feb. 18, 1882		McRoberts, George, Todhill, Newton Mears, Renfrewshire, N.B.
Feb. 18, 1892		Meacham, Chas. Stephen, 62, Earl-street, Maidstone
Feb. 16, 1871	Trans	‖Meldola, Raphael, F.R.S., 6, Brunswick square, W.C.
May 20, 1875		Melmore, Pattinson B., Chemical Laboratory, Maryport
Nov. 19, 1885		Menzies, Thomas J., M.A., B.Sc., Rector, Stranraer Academy, Stranraer, Wigtown
Dec. 18, 1884		Mercer, Francis M., 89, Bishopsgate-street-within, E.C.
Dec. 5, 1889		Mercer, Thomas, Great Hey, Edenfield, near Bury, Lancashire, and ring Bank Brewery, Edenfield, near Bury
May 7, 1891		Merrils, Frederick Johnson, 371, Glossop-road, Sheffield
Feb. 18, 1875		Merry, James Sanders, 5, Richmond-villas, Swansea
April 20, 1876	Trans.	‖Messel, Rudolph, Ph D., Silvertown, Essex
June 21, 1888		‖Miers, Henry A., M.A., F.G.S., Eden Cottage, Beckenham, Kent
Dec. 18, 1843		‖Millar, James, care of Andrew M. McCrindell, 76, Buccleuch, street, Glasgow
Feb. 18, 1892		Millar, James Hill, Mason College, Birmingham
Feb. 19, 1891		Millard, Edgar J., 50, Hillside-road, Stamford Hill, N.
Feb. 19, 1880	Trans.	‖Miller, A. K., Ph.D., Ardwick Brewery, Manchester
Feb. 21, 1889		Miller, Harry East, Ph.D., 1264, Fourteenth-street, Oaklands, California
April 4, 1889	Trans.	Miller, James Bruce, A.I.C., Rubislan, Den North, Aberdeen
Dec. 1, 1887	Trans.	Miller, John A., Niagara University, Buffalo, New York
May 7, 1885	Trans.	‖Miller, N. H. J., Ph.D., Harpenden, Hertfordshire
Dec. 18, 1862	Trans.	‖Mills, E. J., D.Sc., F.R.S., Young Professor of Technical Chemistry in the Glasgow and West of Scotland Technical College, 60, John-street, Glasgow
May 7, 1885		‖Milne, Alexander, M.A., M.B., Surgeon, Indian Medical Department, Bombay, and Byculla, Bombay

Date of Election.		
June 21, 1877		Milne, G. A., 24, New Queen-street, Scarborough
May 5, 1892		Milnes, Ernest E., Ashfield, Bradford
Dec. 1, 1887		Mingaye, John C. H., Department of Mines, Assay Branch, Sydney
April 15, 1886		Minty, Henry Oliver, 38, Kestrel-avenue, Herne-hill, S.E.
May 7, 1891		Mitchell, Charles Ainsworth, B.A. Oxon., Farnley-road, South Norwood, S.E.
June 18, 1891		Mitchell, Thomas, c/o E. Mitchell, Esq., Crossmount, Bridgend, Perth, N.B.
Feb. 15, 1872	Trans	‖Mond, Ludwig, F.R.S., 20, Avenue-road, St. John's-wood, N.W.
Feb. 18, 1892		Mond, Robert Ludwig, M.A., F.R.S.E., The Poplars, 20, Avenue-road, Regent's Park, N.W.
Dec. 18, 1879		‖Mondy, Edmund F., Government Engineering College, Howrah, Calcutta, India
Mar. 3, 1887	Proc.	‖Moody, G. Tattersall, D.Sc., The Ferns, Therapia-road, Honor Oak, S.E.
May 5, 1892		‖Moor, Cresacre George, B.A., 101, Leadenhall-street, E.C.
Dec. 2, 1886		Moos, N. A. F., Poona, India
Feb. 19, 1891		Moore, Frederick Herbert, 45, St. Mary's-road, Peckham, S.E.
Mar. 6, 1890		Moore, Ira, Ph.D., 70, Taylor-street, Tonge, Middleton, near Manchester
Feb. 18, 1864		Morfit, Campbell, Ph.D., 132, Alexandra-road, Abbey-road, N.W.
Feb. 21, 1889		Morgan, Arthur F., Chemical Laboratory, Central Chambers, Newport, Mon.
Jan. 7, 1888		‖Morgan, John James, Milton Lodge, Brecon-road, Abergavenny, Mon.
April 3, 1873		Morgan, William, Ph.D., The Technical Institute, Nelson-terrace, Swansea
June 17, 1880	Trans.	Moritz, Edward R., Ph.D., 72, Chancery-lane, W.C.
Dec. 18, 1879	Trans.	‖Morley, H. Forster, M.A., 29, Kylemore-road, West Hampstead, N.W.
May 5, 1892		Morris, Albert, 115, Hope-street, Dunkinfield
Feb. 19, 1880	Trans.	Morris, G. Harris, Ph.D., 6, Alexander-road, Burton-on-Trent
Dec. 3, 1874		Morris, John Edward, Park Dale, Wolverhampton
Dec. 3, 1891		Morris, Joseph, Stamford-street, Mossley, near Manchester
Nov. 4, 1869		Morrison, John, Chemical Engineer, St. Peter's Chemical Manure Works, Newcastle-on-Tyne
May 7, 1891		Morrison, George R., Richmond House, Plaistow, Essex
June 20, 1889		Morrow, Henry W., M.S., Ph.D., 604, Market-street, Wilmington, Delaware, U.S.A.
Dec. 15, 1851		Morson, Thomas, 124, Southampton-row, Russell-square, W.C., and 42, Gordon-square, W.C.
Feb. 16, 1872		Morton, Edward Handfield, Hook House, Hook, near Winchfield, Hampshire

Date of Election.		
Feb. 7, 1884		Morton, Percy, Christ College, Brecon, South Wales .
April 17, 1890	Trans.	Mosenthal, Henry de, 220, Winchester House, Old Broad-street, E.C.
Jan. 19, 1871		‖Moss, John, Galen Works, Wilson-street, New Cross-road, S.E.
Jan. 19, 1871		Moss, Richard J., F.I.C., St. Aubyn, Ballybrack, Co. Dublin
Dec. 2, 1880		‖Mott, H. A., Ph.D., 61, Broadway, Room 56, New York
April 15, 1886		Moul, Frank, Aldersgate Chemical Works, Southall
June 21, 1888		Mousley, Frank, c/o E. Jackson, 5, Grantham-road, Sparkbrook, Birmingham
June 18, 1891		Mousley, H. J. Marston, Kingsbury, 26, Portland-road, Edgbaston
Feb. 16, 1884		‖Moyle, R. E., B.A., Heightley, Chudleigh, Devon
June 19, 1884	Trans.	Mueller, Baron Ferdinand Von, K.C.M.G., M. and Ph.D., F.R.S., Melbourne, care of Dulau and Co., 37, Soho-square
Jan. 17, 1889		Muir, James, The Yorkshire College, Leeds
Feb. 16, 1871	Trans.	Muir, M. M. Pattison, M.A., F.R.S.E., Fellow and Prælector in Chemistry, Gonville and Caius College, Cambridge
Mar. 30, 1870		‖Muirhead, Alexander, D.Sc., Oakwood, Farquhar-road, Upper Norwood, S.E.
Feb. 3, 1859	Trans.	‖Müller, Hugo, Ph.D., F.R.S., 110, Bunhill-row, E.C.; and 13, Park-square East, Regent's-park, N.W.
April 17, 1890		Müller, George, Prof., Ph.B., Curry Hotel, Ironwood, Michigan, U.S.A.
May 5, 1892		Mulrenan, Joseph Charles, 45, Manor-road, Stoke Newington, N.
Mar. 15, 1888		Munroe, Charles E., Prof. Columbia University, Washington D.C., U.S.A.
Dec. 7, 1871		‖Munro, Donald, M.D., C.M., D.P.H., Medico-Legal Department, University of Glasgow
Feb. 17, 1876	Trans.	Munro, J. M. H., D.Sc., College of Agriculture, Downton, Salisbury
Jan. 21, 1869		‖Muspratt, E. K., Seaforth-hall, near Liverpool
Dec. 3, 1873		‖Muspratt, Sidney Knowles, 51, Croxteth-road, Liverpool
Dec. 4, 1890	Trans.	Murray, Thomas Smith, Chemical Department, Marischall, College, Aberdeen
Nov. 3, 1870	Trans.	Muter, John, M.A., Ph.D., F.R.S.E., F.I.C., Central Public Laboratory, 325, Kennington-road, London, S.E., and Winchester-house, Kennington-road, S.E.
Dec. 4, 1890		Myers, Harry C., Messrs. Benton, Myers, and Co., Cleveland, Ohio, United States, America
Feb. 18, 1892		Myers, William Shields, B.Sc., care of George Lambert, Esq., 209, Townsend-street, New Brunswick, New Jersey, U.S.A.
Mar. 6, 1890		Myles, John, M.A., B.Sc., Butterburn Hamilton
Feb. 3, 1887		Nagel, David Henry, M.A., Trinity College, Oxford

Date of Election.		
Mar. 5, 1874		‖Napier, Arthur S., care of Herren Mayer & Müller, 51, Markgrafen-strasse, Berlin, W., Germany
June 21, 1877		Napier, James, 89, London-road, Ipswich
Dec. 5, 1878		Napper, Edward W., The Hollies, Vicarage-lane, Bowdon
Feb. 7, 1878		Nason, Henry B., Ph.D., M.D., LL.D., Prof. of Chemistry, Rensselaer Polytechnic, Troy, State of New York
Dec. 3, 1891		Naylor, William, 16, Walton's-parade, Preston
April 4, 1878		Naylor, W. A. H., 38, Southwark-street, S.E.
Dec. 3, 1891		Neilson, Thomas, care of the Oregon Iron and Steel Company, Oswego, Oregon, U.S.A.
April 4, 1889		Nesbitt, William Beattie, B.A., M.D., 270, College-street, Toronto, Ontario, Canada
Dec. 5, 1889		Nettleton, J. A., care of Messrs. Higgins and Co., Avoniel Distillery, Belfast
April 4, 1878	Trans.	‖Nevile, R. H. C., Crown Lea, Malvern
June 1, 1871	Trans.	Nevill, Edmund Neville, Government Laboratory, Durban, Natal
April 17, 1890	Trans.	Neville, Francis Henry, Sidney College, Cambridge
June 16, 1892		Newall, John Fenton, 8, Market-place, Manchester
June 4, 1885		‖Newbolt, Francis George, Oakley-lodge, Weybridge
April 19, 1860	Trans.	‖Newlands, John A. R., Laboratory, 27, Mincing-lane, E.C.
Feb. 18, 1864		Newlands, B. E. R., 11, Dunsmure-road, Stamford-hill, N.
Dec. 3, 1891		‖Newlands, William, P. R., Rosa, North-West Province, India
Feb. 6, 1890		Newman, William Samuel, The Leez, Madras, India
April 4, 1889		Newsholme, G. T. Wilkinson, 74, Market-place, Sheffield
Dec. 7, 1882		Newton, Henry Charles, 47, Callcott-road, Hampstead
Dec. 18, 1879		‖Newton, Howard, Singapore, Straits Settlements
Mar. 4, 1886		Newton, Walter, Park-green, Macclesfield
Mar. 1, 1883		Newton, William, Ph.D., F.I.C., 18 and 19, Fenchurch-street, E.C.
Dec. 15, 1892		Nickolls, J. Bate, The Laboratory, Guernsey
Feb. 16, 1870	Trans.	‖Nicholson, Edward, Brigade Surgeon, 45, Crosby-road, Seaforth, Liverpool
June 4, 1885		Nicholson, T. Goddard, St. Thomas' Hospital, S.E.
Dec. 5, 1889		Nickels, Wallace Christopher, 14, Yew-grove, Cricklewood, N.W.
Feb. 1, 1883	Trans.	Nicol, W. W. J., Mason College, Birmingham
May 6, 1869		Noble, Captain A., Engineer, Elswick Ordnance Works, Newcastle
Dec. 5, 1889		Norman, John T., 78, Chelverton-road, Putney, S.W.
April 4, 1861		Norrington, Frederick, 3, Downfield-road, Clifton, Bristol
June 16, 1892		Norris, Charles James, Greville House, Great Malvern
April 17, 1879		North, W., M.D., Nedderdale, Chapter-road, Willesden Green, N.W.
May 5, 1892		Northing, John, 96, Tritonville-road, Sandymount, Dublin
Dec. 18, 1854		Norton, Fletcher, Claremont, Huyton, Liverpool

Date of Election.		
April 4, 1878		‖Norton, Prof. T. H., Ph.D., University of Cincinnati, Ohio, U.S.A.
June 18, 1891		Notter, J. Lane, M.A., M.D., West Cliff, Woolstone, Southampton
Mar. 4, 1886		Obach, Eugene, Ph.D., F.I.C., 2, Victoria-road, Old Charlton, Kent
Mar. 3, 1887		O'Connor, J. William, Messrs. Flower and Sons, The Brewery, Stratford-upon-Avon
May 15, 1890		Oddy, Robert Walter, Waterhouse, Toad-lane, Rochdale
Jan. 19, 1873		Odling, Walter, 132, High-street, and at Messrs. Bass & Co., Burton-on-Trent
Jan. 17, 1848	Trans.	Odling, William, M.B., F.R.S., 15, Norham Gardens, Oxford
May 4, 1871		Ogston, G. H., Analytical Laboratory, 39, Lime-street, E.C.
Dec. 2, 1875		Oman, J. Campbell, Prof., Government College, Lahore, Punjab, India
May 6, 1858		O'Neill, Charles, 14, Cecil-street, Greenheys, Manchester
June 20, 1889		O'Mahony, D. J., Queen's College, Cork
Dec. 4, 1890		Ormandy, Wm. Reginald, Chemical Laboratory, Owens College, Manchester
Nov. 4, 1869		Orme, Temple A., University College, W.C.
May 16, 1872		‖Ormerod, Joseph Arderne, M.B., M.R.C.P., 25, Upper Wimpole-street, W.
Dec. 1, 1887		‖Ormiston, Archibald R., Heathland, Uddingston; and 203, St. Vincent-street, Glasgow
Feb. 21, 1884	Proc.	Orsman, W. J., jun., The Roburite Explosives Co., Gathurst, near Wigan
Mar. 17, 1881	Trans.	O'Shea, L. Trant, Firth College, Sheffield
Dec. 1, 1887		Ostersetzer, Julius, Messrs. W. and H. M. Goulding, Manure Manufacturers, Dublin
April 20, 1876	Trans.	†O'Sullivan, C., F.R.S., 140, High-street, Burton-on-Trent
Mar. 1, 1883		O'Sullivan, James, 26, Ashby-road, Burton-on Trent
Mar. 17, 1887		O'Sullivan, Patrick T., 57, Great Britain-street, Cork
May 7, 1891		Ough, Lewis, 6, Upper King-street, Leicester
Feb. 16, 1888		Overbeck, Otto G. S. L., 10, Town Hall-street, Grimsby
June 16, 1887		Overend, Fred. Lawrence, B.A. (Oxon), Blair Lodge School, Polmont Station, N.B.
Feb. 19, 1891		Oxford, Arnold Whitaker, Rev. M. A., 8, Henrietta-street, Cavendish-square, W.
Dec. 15, 1851		Oxland, Robert, Dr., 32, Portland-square, near Plymouth
Dec. 21, 1871	Trans.	‖Page, Frederick James Montague, B.Sc., 98, Alderney-street, Lupus-street, S.W.

† Longstaff Medallist, 1884.

Date of Election.		
Jan. 17, 1884		‖Pallister, J. W., B.Sc., Heathfield-terrace, Cottage-road, Headingley, Leeds
May 4, 1882		Palmer, Alfred Neobard, 19, King-street, Wrexham, North Wales
Nov. 19, 1868	Trans.	‖Palmer, Dr. W. J., 32, Bassett-road, W.
April 19, 1888		Palmer, Henry John, Penleigh House, Cotham Grove, Bristol
April 17, 1879		Palmer, Walter, Westfield, Reading
Jan. 19, 1882		Parker, Joseph R., Fairbrace Villa, Sussex-avenue, Ashford, Kent
Dec. 7, 1882		‖Parker, R. H., 35, Clifton-road, Maida-vale, W.
Jan. 17, 1889		Parker, Robert Hodgson, c/o Mr. Parker, senr., Buckingham-villa, Keynsham, Bristol
Dec. 5, 1889		Parker, T. Gordon, Ashton Lodge, Leigh-road, Clifton
Nov. 20, 1890		Parkes, Thomas, 30, Hopwood-street, Barnsley
Nov. 2, 1865	Trans.	‖Parkinson, James, F.G.S., Queen's-chambers, Pirie-street, Adelaide, South Australia
Feb. 18, 1892		Parry, Ernest John, B.Sc., Brooklands, Bentham Manor-road, Thornton Heath
Feb. 17, 1876	Trans.	Parry, John, Ebbw Vale Works, Monmouthshire
May 17, 1888		Parsons, William, Dispensary, St. Bartholomew's Hospital, E.C.
Feb. 19, 1880		Pasley, H. F., Hanover-chambers, 8, King-street, Manchester
April 21, 1870		Patchett, Isaac, F.I.C., 1, Leopold-square, Leeds
June 21, 1888		Paterson, James Rymer, B.Sc., 10, Millerfield-place, Edinburgh
Mar. 5, 1885	Trans.	Patterson, George, The Mambré Saccharine Co., Fulham Palace-road, Hammersmith, S.W.
Mar. 17, 1870	Trans.	Patterson, T. L., care of Messrs. John Walker and Co., Greenock
Dec. 3, 1863	Trans.	Pattinson, John, 75, The Side, Newcastle-upon-Tyne
Mar. 5, 1868	Trans.	‖Paul, Dr. B. H., Analytical Laboratory, 1, Victoria-street, Westminster, S.W.
Dec. 3, 1885	Trans.	Paul, Lewis Gordon, Ph.D., Messrs. Read, Holliday and Sons, Huddersfield
Jan. 17, 1889		Peace, Frank Kenworthy, c/o George Peace, Monton Grange, Eccles, near Manchester
Jan. 16, 1874		Pearce, William, jun., Chemical Works, Bow Common, E.
Feb. 4, 1870	Trans.	‖Pedler, Alexander, Prof., Presidency College, Calcutta
Jan 17, 1884		Peile, Henry, Shotley Bridge, co. Durham
May 20, 1886		Pendlebury, William Henry, M.A., Ch. Ch., Oxon, and 6, Gladstone-terrace, Dover
Mar. 7, 1870		Penney, M. D., 11, High-street, Hull
Dec. 16, 1886		Pentecost, Stephen James, Nottingham-road, New Basford, Nottingham
Dec. 7, 1882		Peppe, Thomas Fraser, Tiril Estate, Ramlin, Bengal, India
Jan. 17, 1889		Percival, John, M.A., Carperby, Bedale, Yorks

Date of Election.		
April 17, 1884	Proc.	Perkin, A. G., 8, Montpelier-terrace, Hyde Park, Leeds
June 18, 1891	Trans.	Pekin, Frederick M., Heriot Watt College, Edinburgh
Dec. 15, 1856	Trans.	†‖Perkin, W. H., Ph.D., F.R.S., The Chestnuts, Sudbury, Harrow
April 17, 1884	Trans.	Perkin, W. H., jun., F.R.S., Fairview, Wilbraham-road, Fallowfield, Manchester
Feb. 6, 1890	Proc.	Perman, Edgar Philip, B.Sc., University College, Cardiff, and 1, Gordon-road, Neath, Cardiff
Dec. 6, 1888		Perry, George Edward, 6, Norwood-villas, Edgbaston, Birmingham
May 2, 1867		Peterson, F. W., Deputy Assay Master, H.M. Mint, Bombay, 54, Talbot-road, Bayswater, W.
June 16, 1881		Philip, Arnold, 43, Onslow-road, Richmond
Feb. 1, 1877		Phillips, A. G., 18, Fopstone-road, Kensington, S.W.
June 20, 1889		Phillips, Benjamin, c/o Messrs Phillips and Co., 3, West street, Finsbury-circus, E.C., and Oriental Bank-buildings, Bombay, India
Feb. 16, 1882		Phillips, Henry Harcourt, 183, Moss-lane East, Manchester
Feb. 21, 1889		Phillips, Henry Joshua, Ebbw Vale Iron Works, Ebbw Vale, Mon.
Jun. 16, 1887		Phillips, J. Stanley, Wentworth, Upper Long Ditton, Surrey
Dec. 7, 1882		Phillips, Samuel E., sen., Wokingham-road, Reading
Jan. 16, 1862	Trans.	Phipson, T. L., Ph.D., Laboratory of Analytical Chemistry, Putney, S.W., and Holtham Villa, Putney, S.W.
Feb. 19, 1891		Pickering, M. Samuel, 40, Price-street, Burslem
Feb. 7, 1878	Trans.	‖Pickering, Percival Spencer Umfreville, M.A., F.R.S., 48, Bryanston-square, W.
April 17, 1890	Proc.	‖Picton, Harold, B.Sc., 80, Regents Park-road, N.W.
Dec. 5, 1889		Pike, Alfred Edridge, Westminster Hospital Medical School, Caxton-street, Westminster, S W.
Jan. 15, 1874	Trans.	‖Pike, William Herbert, Ph.D., University College, Toronto, Canada
Dec 2, 1887		Pilkington, Herbert, M.I.M.E., Midland Coal, Coke, and Iron Company, Apedale, near Newcastle, Staffordshire
Dec. 20, 1883		‖Pilley, John J., Ph.D., Crescent Lodge, Camberwell Grove, S.E.
Dec. 5, 1889		Ping, William, 2, Sandbourne-road, Brockley, S.E.
Feb. 21, 1889		Pingstone, G. Arthur, 5, Speenham-road, Brixton, S.W.
Mar. 17, 1881		Pisani, O. V., Gibraltar-house, Rochmount-road, Upper Norwood
Feb. 16, 1882		Pitt, Theophilus, 16, Coleman-street, E.C.
April 4, 1889		Platts, John Charles, 25, Harcourt road, Crookesmoor, Sheffield
Dec. 4, 1890		Platts, Thomas, 7, Victoria-street, London, S.W.
Nov. 15, 1860		‖Player, J. H., Thatcham House, Thatcham, Berks
Feb. 23, 1841	Trans.	‖*Playfair, Lord, K.C.B., F.R.S., 68, Onslow-gardens, South Kensington

† Longstaff Medalist, 1888.

Date of Election.		
Dec. 2, 1880	Trans.	Plimpton, R. T., Ph.D., 23, Lansdowne-road, Clapham-road. S.W.
April 1, 1858		Pochin, Henry Davis, c/o W. G. Gover, 3, Malvern-villas, Camden-road, Bath
June 7, 1888		Pollard, F. Ernest, Old Cross, Hertford
Dec. 4, 1890		Pond, James Alexander, Auckland, New Zealand
Dec. 4, 1848		Pontifex, Edmund A., M.I.C.E., 72, Cornwall Gardens, S.W.
Mar. 6, 1862		Pooley, Thomas A., B.Sc., F.I.C., 121, The Grove, Denmark Hill, S.E.
Feb. 19, 1891		Pope, Wm. Jackson, Central Institution, Exhibition-road, S.W.
Feb. 16, 1882		Porter, Herbert, 22, Waldegrave-road. Norwood, S.E.
Dec. 18, 1884		Porter. T. Cunningham, Rev., Eton College, Windsor
Dec. 6, 1883		Potter, Charles E., care of Messrs. Tate & Sons, Love-lane Sugar Refinery, Liverpool
Feb. 21, 1884		Power, Francis R., The Royal Mint, Melbourne
April 15, 1880		Preller, Charles S. Du Riche, Loch Broom House, 18, Margaret-street, Cavendish-square, W.
May 19, 1864		‖Prentice, Manning, Woodfield, Stowmarket
Mar. 2, 1876	Trans.	Prescott, Albert B., M.D., University, Ann Arbor, Michigan, U.S.A.
May 16, 1861		Prestwich, Joseph, F.R.S., Shoreham, Sevenoaks, Kent
Dec. 5, 1872	Trans.	Prevost, E. W., Ph.D., Elton, Newnham Gloucester
May 4, 1882		‖Price, Arthur F., 524, Sacramento, San Francisco
Jan. 17, 1889		Priestlay, Charles W., B.Sc., Avonbrook, Tewkesbury, Gloucester
Dec. 3, 1891		Priestley, Lawrence. Newark-on-Trent
Feb. 17, 1870		Pritchard, Prof. William, President Royal Veterinary College, N.W.; and 5, Regent's Park-road, Gloucester-gate, N.W.
June 15, 1871	Trans.	Procter, Henry R., F.I.C., The Yorkshire College, Leeds
April 4, 1889		Proctor, Charles, Upland House, 359, Upland-road, Dulwich, S.E.
Jan. 17, 1889		Provis, John, Emu Bay, Tasmania
June 15, 1882		‖Pullar, Rufus D., Ochil, Perth
Nov. 15, 1888	Proc.	Pullinger, Frank, B.A., 27, Queen's-road, Oldham
Feb. 18, 1892	Trans.	Pullinger, William, 27, Queen's-road, Oldham
June 21, 1883		Purcell, M. F., 71, Harcourt-street, Dublin
June 3, 1875	Trans.	Purdie, Thomas, Ph.D., B.Sc., Assoc. R.S.M. University, St. Andrews, N.B.
Dec. 2, 1886		Pyke, L. S. M., St. Stephen's Club, Westminster, S.W.

Dec. 2, 1886		Quayle, Edwin, F.I.C., 3, Addison-terrace, Victoria Park, Manchester
Mar. 4, 1868		Quibell, Oliver, Magnus Lodge, Newark-on-Trent
Dec. 5, 1889	Trans.	Quincke, Frederick, Ph.D., 25, Alma-square, Abbey-road, N.W.

Date of Election.		
April 17, 1879		Rait, George Logan, 5, Fordwych-road, West Hampstead, N.W.
Dec. 15, 1892		Ramage, Hugh, Royal College of Science, Dublin
Nov. 15, 1888		Ramsay, A. Alexander, Anan Villa, Rose-road, Auckland
Mar. 20, 1873	Trans.	‖Ramsay, W., Ph.D., F.R.S., University College, W.C.
May 7, 1891		Randall, Percy Morrice, 3, Belsize Park Gardens, N.W.
April 18, 1843		Randall, William B., Glenhurst, Southampton
Dec. 3, 1885		Ranken, Charles, Stockton-road, Sunderland
May 16, 1889		Ransom, Francis, Bedford-road, Hitchin
April 21, 1887		Rawlins, Edward, 114, Burley-road, Leeds
June 17, 1880		Rawson, Christopher, The Bradford Technical College, Bradford
Jan. 17, 1884	Trans.	‖Rawson, Sidney George, D.Sc., Westbourne, Westbourne-grove. West Kirby, Cheshire
June 17, 1886		Ray, William, Fir Bank, Hereford-square, Sale, near Manchester
April 4, 1889		Read, Arthur A., Ventnor House, Honiton, Devon
April 4, 1889		Reckitt, Ernest, B.Sc., 12, St. John's-terrace, Dawes-road, Fulham, S.W.
Nov. 20, 1890		Redding, Richard James, 17, Leghorn-road, Plumstead, S.E.
Jan. 15, 1874		‖Reddrop, Joseph, Laboratory, London and North West. Ry., Crewe
July 16, 1892		Redman, Henry Ramsden, 10, The Gardens, East Dulwich, S.E.
June 20, 1889		Redwood, Robert, 4, Bishopsgate-street-within, E.C.
Jan. 18, 1866		Redwood, Boverton, F.R.S.E., 4, Bishopsgate-street-within, E.C.
Mar. 17, 1887		Redwood, T. Horne, 2, Fisher-street, Red Lion-square, W.C.
Nov. 18, 1886	Trans.	Rée, Alfred, Ph.D., 1, Brighton-grove, Rusholme, Manchester
Nov. 16, 1882		Reed, Lester, F.I.C., Hyrst-hof, 8, South Park-hill-road, Croydon, S.E.
April 15, 1880		‖Regester, William, Lawn-lodge, Isleworth, Middlesex
Dec. 15, 1881		Reid, Walter Francis, Fieldside, Addlestone, Surrey
June 17, 1886		Remington, J. Price, Prof., 1832, Pine-street, Philadelphia, Pa., U.S.A.
Feb. 6, 1879	Trans.	Rennie, Edward H., Ph.D., University of Adelaide, S. Australia
May 17, 1888		Reynolds, Colonel Henry Charles, Thorncliff, Sandown-road, Cheltenham
June 19, 1873	Trans.	Reynolds, James Emerson, Prof., F.R.S., Trinity College, Dublin,
Nov. 19, 1857		Reynolds, Richard, 13, Briggate, Leeds
Nov. 15, 1888		Rhodes, Clement T., 144, South Broadway, Aurora, Kane County, Illinois, United States, America
June 18, 1891		Rhodes, Edward, Holly Bank, Frodsham, Cheshire
May 18, 1876		Richards, D. H., Bryntirion, Oswestry
April 4, 1889		Richards, Duncan T., 3, Madeira-terrace, Westoe-lane, South Shields
Jan. 17, 1889		Richards, Edgar, 113, East 30th-street, New York
Jan. 17, 1889		Richards, Percy A. E., A.I.C., 44, Sinclair-road, Kensington, W.
June 17, 1886		Richards, William, B.Sc., The Clock House, Tooting, S.W.
May 5, 1892		Richardson, Albert Ernest, Dorking, Surrey

Date of Election.		
June 18, 1885	Trans.	‖Richardson, Arthur, 22, Meridian-place, Clifton, Bristol
Feb. 16, 1888		‖Richardson, Clifford, Office of the Engineer Commissioner, Washington, D.C., U.S.A.
Feb. 1, 1883		Richardson, F. W., 2, Farcliffe-place, Bradford
Mar. 6, 1873		Richardson, Henry, 127, Elizabeth-street, Cheetham, Manchester
Dec. 6, 1888		Richardson, Hubert N. B., The Hawthorns, Knighton Park-road, Leicester
April 19, 1866		Richardson, Joseph, jun., 40, Warwick-road, Chorlton-cum-Hardy, Manchester
Dec. 1, 1864		Richardson, J. G. F., Ph.D., Elmfield, Knighton, Leicester
May 5, 1892		Richardson, Reginald, E. S., Elmfield, Knighton, Leicester
Nov. 17, 1887		Richardson, W. H., Dudley
Mar. 3, 1887		Richmond, H. Droop, 50, Clanricarde-gardens, Notting-hill-gate, W.
Feb. 3, 1845		Rickard, W. T., 136, Maygrove-road, West Hampstead, N.W.
Dec. 7, 1882	Trans.	Rideal, Samuel, D.Sc., Hotel Kulm, St. Moritz, Engadine
April 3, 1873		Rider, Alonzo John, 4, Haddington-road, Stoke, Devonport
Feb. 16, 1882	Trans.	Ridsdale, C. H., Hutton-grange, Guisbrough, Yorks
Dec. 6, 1888		Rigby, John S., 35, Bagot-street, Wavertree, Liverpool, and Ditton, Lancashire
Dec. 15, 1851	Trans.	Riley, Edward, 14A, Finsbury-square, E.C.
Dec. 4, 1873		Rimmington, F. M., Bradford
Mar 3, 1864		Ritchie, William, jun., Kincaid-field House, Milton of Campsie, Glasgow
April 18, 1872		Robbins, John, 57, Warrington-crescent, Maida-vale, W.
June 20, 1889		Roberts, Emmanuel, M.D., Moratua, Ceylon
June 21, 1883		Roberts, Frederick G. Adair, Warton-road, Stratford, E.
Jan. 20, 1876		Roberts, Martin F., Postal Telegraph Engineers' Department, Gloucester-road, N.W.
April 4, 1889		Roberts, R. Wightwick, Rowancroft, Heavitree, Exeter, and Valparaiso, Chili
Feb. 19, 1880		Roberts, W. Brittain, Wilderspool House, Warrington, Lancashire
Nov. 7, 1866	Trans.	Roberts-Austen, William Chandler, C.B., F.R.S., Royal Mint, E.
Mar. 17, 1887		Robertson, George, Madeira-villa, Woodford Green, Essex
Dec. 4, 1890		Robertson, George Henry, 30, Hemstall-road, West Hampstead, N.W.
Feb. 21, 1889		Robins, Harry H., Messrs. Southwell and Co., Dockhead, S.E.
May 5, 1881		Robinson, G. Carr, Royal Institution, Hull
Nov. 16, 1882	Trans.	Robinson, Henry H., M.A., Imperial College, Hankow, China
May 3, 1866		Robinson, John, Ellesmere Mansions, Canfield-gardens, Hampstead. N.W.
Dec. 20, 1883		Rogers, Arthur W., 66, Firzwalter-road, Norfolk Park, Sheffield
Jan. 17, 1884		Rogers, Francis M., 21, Burma-road, Stoke Newington, N.
April 15, 1886		Roose, Robson, M.D., 45, Hill-street, Berkeley-square, W.

Date of Election.		
Dec. 17, 1855	Trans.	Roscoe, Sir H. E., M.P., LL.D., F.R.S., 10, Bramham-gardens, South Kensington, S.W.
Feb. 19, 1891		Rose, Tom Kirke, 9, Royal Mint, E.
Feb. 17, 1870		Ross, Lewis Buttle, Driffield
Dec. 15, 1881		Ross, Rev. Henry, LL.D., Dallas House, Lancaster
June 18, 1891	Proc.	Rossiter, Edmund Charles, 5, Magdala Cottages, Langley, Green, Birmingham
Feb. 18, 1892		Rothewell, C. F. Seymour, 82, Mawson-street, Ardwick Green, Manchester
Mar. 6, 1890		Rothwell, Robert R., 82, Mawson-street, Ardwick Green, Manchester
Dec. 19, 1872	Trans.	Routledge, Robert, B.Sc., The North-Eastern Railway Laboratory, Greenfield, Gateshead-on-Tyne
Mar. 21, 1848	Trans.	Rowney, Thomas H., Ph.D., Salerno, Salt Hill, Galway
June 17, 1880		||Roy, Tarapusanna, Medical College, Calcutta
Mar. 20, 1862		||Royle, Thomas, Dalton House, Upton-lane, Forest Gate, E.
Feb. 15, 1872	Trans.	Ruffle, John, 21, Gnoll-park-road, Neath, South Wales
Jan. 17, 1889	Trans.	Ruhemann, Siegfried, Ph.D., M.A., Gonville and Caius College, Cambridge
Feb. 15, 1883		Rumble, Charles, 31, Oberstein-road, New Wandsworth
Feb. 6, 1890		||Russell, Edward, 36, Lucerne-road, Highbury Park, N.
Mar. 3, 1851	Trans.	||Russell, W. J., Ph.D., F.R.S., 34, Upper Hamilton-terrace, St. John's-wood, N.W.; and St. Bartholomew's Hospital, E.C.
Feb. 16, 1870		||Rylands, Thomas Glazebrook, F.L.S., Highfields, Thelwall, near Warrington
June 7, 1888		Sach, Albert J., Technical School, Goulburn, New South Wales
Feb. 19, 1891		Sacré, Howard C., 5, Ecclesford-road, Manchester
June 18, 1868		Sadler, S. A., Dr., Cleveland Chemical Works, Middlesborough
May 4, 1882		Sadtler, Samuel P., Ph.D., 145, North 10th-street, Philadelphia, U.S.A.
June 19, 1879	Trans.	||Sakurai, J., Tokio University, Japan
Dec. 20, 1883	Trans.	||Saint, W. Johnston, Reuter Strasse, 2A, Poppelsdorf vei Bonn, Germany
Feb. 19, 1880		Salamon, Alfred Gordon, 160, Sutherland-avenue, W.
Feb. 19, 1880		Salet, George, 120 Boulevard St. Germain, Paris
May 4, 1876		||Salomons, Sir David Lionel, Broomfield, Tunbridge Wells; and Berkeley Chambers, 13, Bruton-street, Hyde-park, W.
April 16 1863		||Salt, Henry, M.D.C.M., F.R.G.S., Inglewood, Great Malvern
Feb. 17, 1859		||Salter, Thomas W., Hamilton House, The Croft, Hastings, Sussex
June 25, 1871		||Salter, Mortyn John, Northcote, Beaconsfield-road, New Southgate
June 21, 1883		Samuel, Albert Henry, Annesley, 167, Lodge-lane, Sefton Park Liverpool

Date of Election.		
May 4, 1882		Samuel, W. Cobden, Wilton Lodge, 337, Norwood-road, West Norwood, S.E.
Mar. 3, 1870	Trans.	‖Sandberg, C. P., 19, George-street, Westminster
Feb. 18, 1892		Sandercock, Thos. J. Buckler, Sidcup College, Sidcup, Kent
Dec. 6, 1888		Sanderson, John, Middlesborough, Kentucky, U.S.A.
Nov. 16, 1882		Sanford, P. Gerald, Blandford-lodge, Streatham, S.W.
Dec. 4, 1890		Saniter, Ernest Henry, The Laboratory, Wigan Coal and Iron Co., Wigan
Dec. 3, 1891		Sanyal, Abhayacharan, M.A., Professor of Physical Science, Queen's College, Benares, N.W.P., India
June 17, 1886		Saunders, Prof. William, Experimental Farm, Ottawa, Ontario, Canada
Feb. 2, 1888		Saunders, W. Sedgwick, M.D., L.R.C.Phys.Ed., M.R.C.S., F.S.A., Medical Officer of Health for City of London, 13, Queen-street, Cheapside, E.C.
Feb. 6, 1890		Sayers, William Charles, 38, High-street, Lewisham, S.E.
Dec. 3, 1885		Scammell, Luther R., 42–4, King William-street, Adelaide, South Australia
June 21, 1877		Scarf, S. Isaac, F.I.C., City of London School, Victoria Embankment, E.C.; and 75, Oxford-road, Islington, N.
Feb. 6, 1873		Schacht, George Frederick, Windsor-terrace, Clifton, Bristol
Dec. 6, 1888		‖Schieffelin, William Jay, 170, William-street, New York, City, U.S.A.
Dec. 2, 1886		Schleselman, James, Victoria-chambers, Dundee
Feb. 18, 1892		‖Schofield, James Alexander, University of Sydney, New South Wales
April 21, 1887		Schubart, Louis H., Ph.D., 160, Water-street, New York, U.S.A.
Mar. 15, 1842	Trans.	Schunck, Edward. Ph.D., F.R.S., Oaklands, Kersall, Manchester
June 18, 1863		Scorgie, James, Poona Villa, King's Gate, Beechgrove-terrace, Aberdeen
Dec. 18, 1879		‖Scott, Alexander, M.A., D.Sc., Chemical Laboratory, University, Cambridge
Dec. 3, 1891		Scott, Charles K., the North Brazilian Sugar Factories Limited, Engenho Central São Lourenço, Tiúma, Brazil
April 17, 1890		Scott, Ernest George, 67, Lord-street, Liverpool
Mar. 3, 1887		Scrutton, W., 18, Billiter-street, London, E.C.
Mar. 1, 1883	Proc.	Scudder, Frank, 146, Earl's-court-road, Earl's court, S.W.
May 7, 1891		Searl, Albert, The Caxtons, Miskin-road, Dartford
Nov. 20, 1890		Seaton, Edward Cox, Ph.D., The Limes, 56, North Side, Clapham Common, S.W.
June 21, 1888		Seely, Herbert W., 11, Corn-market, Halifax
April 15, 1875		Sellon, Scudamore, The Hall, Sydenham, S.E.
Feb. 16, 1882		Sells, V. Perronet, 1, Woodsley-terrace, Leeds

Date of Election.		
Mar. 4, 1875	Trans.	Senier, Alfred, M.D., Ph.D., Thornfield, Harold-road, Upper Norwood, S.E.
June 21, 1887	Trans.	Senier, Harold, 88, Norwood-road, Herne-hill, S.E.
Mar. 6, 1890		Sergeant, Edward, L.R.C.P. (Lond.), M.R.C.S. (Eng.), County Offices, Preston, Lancashire
Feb. 1, 1883		Serre, Charles A., Mitre Chemical Works, Cordova-road, Grove-road, Mile End.
Jan. 20, 1870	Trans.	Seward, Henry, c/o Messrs. J. B. Freeman, Sons, and Co., Wandle Colour Works, Wandsworth, S.W.
Feb. 19, 1874		||Sexton, A. Humboldt, F.I.C., F.R.S.E., Professor of Metallurgy, Metallurgical Department, Andersonian-buildings, 204, George-street, Glasgow
June 20, 1880		Shadwell, J. E. L., Meadowbanks, Melksham, Wilts
Feb. 20, 1873		Shapleigh, Waldron, Welsbach Incandescent Gas Light Co., Factory, Gloucester City, New Jersey, U.S.A.
June 4, 1874		Sharman, William, 247, Mare-street, Hackney, N.E.
June 18, 1885		Sharp, James, The Towers, Low Moor, near Bradford
Feb. 2, 1888		Shaw, Frederic W., Laboratory, Heapy Bleach Works, near Chorley, Lancashire
Feb. 21, 1883		Shaw, Harry G., 628, Montgomery-street, Room 47, San Francisco, California, U.S.A.
Feb. 6, 1890	Trans.	Shaw, Saville, Durham College of Science, Newcastle-upon-Tyne
Feb. 19, 1891		Shaw, Herbert D., Ilkley, Yorkshire
June, 16, 1887		Sheard, John T., 273, Main-street, Bridgetown, Glasgow
April 4, 1889		Shegog, Thomas Alexander, 4, Omsbersley-road, West Park, Newport, Mon.
Feb. 17, 1876	Trans.	Shenstone, W. A., Clifton College, Bristol ; and 12, Clifton Park-road, Clifton, Bristol
May 21, 1874		||Shepherd, H. H. B., Northcote, Mount Pleasant-lane, Upper Clapton, N.E.
Dec. 16, 1886		Sheshadri, P. Y., The Mission House, Bethel, near Jaulna, via Bombay, India
June 18, 1891	Trans.	||Shields, John, Ph.D., B.Sc., University College, W.C.
Dec. 16, 1886	Trans.	Shimidzu, T., c/o J. Takamine, 907, Chamber of Commerce, Chicago, Ills., U.S.A.
April 19, 1883		Shopoff, Vulko Ivan, Philippopolis, South Bulgaria
Mar. 19, 1874		Shore, Thomas William, F.G.S., Hartley Institution, Southampton
Nov. 18, 1886		Shutt, Frank, M.A., Experimental Farm, Ottawa, Canada
April 17, 1890		Shuttlewood, W. Brewin, 2, Woodland-villas, South Woodford, Essex
May 16, 1889		Sibson, Alfred Edward, 2, St. John's-villas, Palmerston-road, Buckhurst Hill, Essex
Dec. 15, 1859		Sibson, Alfred, 23, St. Mary Axe, E.C.

Date of Election.		
April 17, 1890		Sibun, James, 2, Lax-terrace, Norton, Stockton-on-Tees
Nov. 29, 1874	Trans.	Siebold, Louis, 18, Exchange-street, Manchester
Dec. 2, 1886		Silvester, Harry, Malvern House, Handsworth, Birmingham
Dec. 3, 1885		Sim, James, 77, Dee-street, Aberdeen
April 4, 1889		Simmonds, Henry, Gas Works, Colne, Lancashire
April 21, 1887		Simmons, L., Fareham, Hants
April 21, 1887		‖Simmons, L. Owen, Wolvesey, Winchester
1857		Simpson, Maxwell, M.D., F.R.S., Queen's College, Cork
May, 29, 1886	Trans.	‖Simpson, William Selby, 95, Darenth-road, Stamford Hill, N.
May 16, 1889		Singer, Ignatius, 13, Holker-street, Keighley, Yorkshire
April 15, 1880		Skelton, J. R., The Homestead, Thorpe Village, Norwich
Feb. 2 1888	Trans.	Skinner, Sidney, M.A., The Cavendish Laboratory, Cambridge
Feb. 18, 1892		Skurray, Thomas, United Breweries, Abingdon, Berkshire
April 17, 1879		Slater, Charles, 16, Northwick-terrace, St. John's Wood, N.W.
April 15, 1880	Trans.	‖Slater, Harold H., Laboratory and Cement Testing Office, Grays, Essex
Dec. 5, 1878		Slatter, George W., A.R.C.S., F.I.C., Saltaire, Yorkshire
April 4, 1889		Slater, John W., 36, Wray-crescent, Tollington Park, N.
Feb. 5, 1863	Trans.	Smee, A. Hutchinson, The Grange, Hackledge, Carshalton, Surrey
Dec. 16, 1875		‖Smetham, Alfred, Analytical Laboratory, Cereal Chambers, 18, Brunswick-street, Liverpool
Dec. 5, 1872		Smith, A. Percy, 83, Temple-chambers, E.C.
June 21, 1883	Trans.	Smith, Adolphe, 19, Barclay-road, Walham Green
April 17, 1890		‖Smith, Alexander, Ph.D., B.Sc., Wabash College, Crawfordsville, Indiana, U.S.A.
April 15, 1880		Smith, Alfred J., 103, Rock-street, Pitsmoor, Sheffield
Feb. 16, 1888		Smith, Angus, 10, Ardgordan-street, W., Greenock, N.B.
Dec. 15, 1881	Trans.	Smith, Bernard E., Alkali Acts Department, Local Government Board, Whitehall, S.W.; and The Grove, Birtley, co. Durham
Feb. 21, 1884		‖Smith, Edgar Francis, 35, Ampthill-square, Hampstead-road, N.W.
Mar. 20, 1878		Smith, Edgar F., Prof., University of Penna., Philadelphia, Pa.
Dec. 9, 1869		Smith, Edward, Heathfield House, Chudleigh, Devon
June 16, 1892		Smith, Ernest Heber, Cambrian-crescent, Chester
Nov. 20, 1892		‖Smith, Fred., c/o W. J. Kent, Esq , Galpin's-chambers, Commissioner-street, P.O. Box 294, Johannesburg
April 2, 1874		Smith, George, Nobel's Explosives Co., Polmont Station, Scotland
Dec. 20, 1883		Smith, George, 141, Lothair-road, North Finsbury Park, N.
Feb. 18, 1892		‖Smith, George P. Darnell, 60, St. Michael's Hill, Bristol
Feb. 6, 1890		Smith, Harry Wood, B.Sc., Messrs. May and Baker, Garden Wharf, Church-road, Battersea

Date of Election.		
May 16, 1892		Smith, H. R., 1, Aubert-park, Highbury, N.
May 5, 1892		Smith, John Meadows, Laboratory, 66, College-street, Chelsea, S.W.
Dec. 18, 1879		Smith, John William, Mass. Institute of Technology, Royston, street, Boston, Massachusetts
Feb. 6, 1873	Trans.	Smith, Miles H., 3, Great Tichfield-street, Oxford-street, W.
Feb. 19, 1891		Smith, R. Greig, Durham College of Science, Newcastle-on-Tyne
Feb. 16, 1888		Smith, Sam, Mena, Union-road, Exeter
Nov. 18, 1886		Smith, Sidney, 35, Ampthill-square, Hampstead-road, N.W.
Mar. 17, 1870		Smith, S. J., C.E., F.G.S., F.S.A., Aucklands, Wandsworth Common, New Wandsworth
April 7, 1856		Smith, Thomas J., F.G.S., Wilton-terrace, Hornsea, East Yorkshire
Feb. 3, 1876		Smith, W. A., M.A., M.B. Oxon, M.R.C.S. Eng., Newport, Essex
Dec. 20, 1866	Trans.	Smith, Watson, University College, Gower-street, W.C.
Dec. 20, 1883	Trans.	Smithells, Arthur, Professor, The Yorkshire College, Leeds
Dec. 18, 1873		‖Smyth, John, M.A., Milltown, Banbridge, Ireland
Mar. 3, 1887	Trans.	‖Snape, Henry Lloyd, Prof., Chemical Laboratories, University College of Wales, Aberystwith
May 16, 1872	Trans.	Snelus, George J., F.R.S., 2, Victoria-mansions, Victoria-street, Westminster, and 42, Lowther-street, Whitehaven
Dec. 18, 1879		Snodgrass, James, 2, Keir-terrace, Maxwell-road, Pollokshields, Glasgow
June, 18, 1891		Soloman, Frank Oakley, North Eastern County School, Barnard Castle
Dec. 17, 1874		Sonstadt, Edward, Church Field, Cheshunt, Herts
Dec. 18, 1884	Trans.	Sorabji Bomanji, Khan Bahadur, Ph.D., C.E. (Bombay) Assoc., M.I.C.E. (Lond.), State Engineer, Rajhipla State, Nandod, India
Feb. 3, 1887		Sohn, Charles, 25, Beverley-road, Anerley
May, 6, 1875		Southall, Alfred, Garrick House, Richmond Hill, Edgbaston
Feb. 21, 1889		Southam, Stanley, 338, Upper Grosvenor-street, Manchester
June 21, 1883		Soward, Alfred W., 144, Friern-road, Dulwich, London, S.E.
Dec. 15, 1892		Spackman, Charles, Fair-view, Sileby, near Loughborough
Feb. 21, 1889		Speakman, James, Penhold, Post Office, Calgary, Alberta, Canada
Jan. 18, 1866		Speir, James, 110, Fenchurch-street, E.C.
Feb. 1, 1883		‖Spencer, Ernest Samuel, Elmstead, Merton-park, Surrey
April 4, 1878		Spencer, James, B.Sc., 38, Ash-grove, Bradford
Mar. 4, 1886		Spencer, Richard, Holker-street, Barrow-in-Furness
Feb. 6, 1879		‖Spencer, Samuel, Wetherby, The Avenue, Lower Norwood
June 16, 1887		Spencer, W. Shelley, 105, Bridge-street, Farnworth, near Bolton, Lancashire
Feb. 3, 1859	Trans.	‖Spiller, John, 2, St. Mary's-road, Canonbury, N.

Date of Election.		
Jan. 15, 1863		Spiller, William, Atlas Dye Works, Hackney-wick, E.
June 18, 1885		Spilsbury, James, Evington, Northumberland-street, Higher Broughton, Manchester
June 4, 1885		Spottiswoode, W. Hugh, Balliol College, Oxford; and 41, Grosvenor-place, S.W.
Feb. 18, 1892		Spray, Henry John, 15, Bucharest-road, Wandsworth, S.W.
Dec. 1, 1864	Trans.	Sprengel, Hermann, Ph.D., F.R.S., Savile Club, 107, Piccadilly, W.
May 4, 1882		Squire, P. Wyatt, 413, Oxford-street, W.
Feb. 4, 1858	Trans.	Squire, W. Stevens, Ph.D., Clarendon House, St. John's Wood-park, N.W.
Feb. 18, 1892		Squires, Alfred James, 16, Lower Sleaford-road, Newark, Notts
May 5, 1892		Stables, William Herbert, B.A., The Hostel, Lincoln
June 21, 1877		Stacey, Henry George, 300, High Holborn, W.C.
Dec. 18, 1879	Trans.	Stallard, George, M.A., Tower Lodge, Bilton-road, Rugby
April 21, 1859	Trans.	Stanford, Edward Charles, Glenwood, Dalmuir, Dumbartonshire
Mar. 17, 1887		Stanger, W. Harry, Chemical Laboratory, Broadway, Westminster
April 15, 1880		Stanley, John William, The Laboratory, Tondu, near Bridgend, Glamorgan
Feb. 3, 1887		Stansell, Lionell W., Bydews, Holland-road, Maidstone, Kent
Dec. 3, 1885		Staples, Henry J., Spondon, Derby
Dec. 15, 1870		Starey Arthur J., 18, Ashley-road, Hornsey-rise, N.
Dec. 15, 1870	Trans.	Stark, J. Fleming, Bromborough Pool, near Birkenhead
Mar. 16, 1876		Starling, J. H., Crossness, Belvidere, Kent
Feb. 17, 1881		Stavert, Rev. W. J., M.A., Burnsall Rectory, Skipton-in-Craven, Yorkshire
Nov. 16, 1882	Trans.	Stead, J. E., Redcar, Middlesborough
May 4, 1882		Stebbins, James H., 114, Pearl-street, New York
June 16, 1887	Proc.	Steedman, Charles Ernest, Abberton House, Strand, Williamstown, Melbourne
May 7, 1885		Steel, Robert Elliot, Hawthorn House, Baildon, near Shipley Yorkshire
Dec. 5, 1889		Steel, Sydney, Fairlawn, Blackheath, S.E.
Dec. 4, 1890		Steel, Thomas, Sugar Refinery, Yarraville, Melbourne, Victoria
Dec. 18, 1884		Steele, Robert R., 8, Adelaide-square, Bedford
Jan. 17, 1884		Stenhouse, Thomas, 8, West-street, Rochdale
May 5, 1892	Proc.	Stenhouse, James, Gas Works, New-street, Edinburgh
Dec. 6, 1883		Stephens, C. W., 116, Wednesbury-road, Walsall
April 15, 1880		Stephens, Henry Charles, M.R. Inst., Avenue House, Finchley
Dec. 3, 1885		Stephenson, Stephen, 98, Kensington, Liverpool
Dec. 3, 1891		Stephenson, Thomas, Bellasis-road, Byculla, Bombay
Dec. 6, 1888		Stern, Arthur Landauer, Messrs. Bass and Co.'s Old Brewery, Burton-on-Trent
Dec. 15, 1881		Steuart, Daniel Rankin, Broxburn, Linlithgowshire

Date of Election.		
Feb. 18, 1864		Stevenson, Thomas, M.D., Sandhurst Lodge, 45, Gresham-road, Brixton, S.W.
Feb. 6, 1879		Stevenson, William, 95A, Southwark-street, S.E.
June 20, 1872		||Stewart, Walter, 22, Torphichen-street, Edinburgh
Feb. 21, 1889		Stillman, Thomas B., Steven's Institute of Technology, Hoboken, N.J., U.S.A.
Dec. 15, 1881		Stitt, Charles Alfred, Hornelen Cheney Gardens, Edinburgh
June 21, 1866		Stock, W. F. K., 5, Dixon-terrace, Darlington
Feb. 19, 1891		Stockdale, R., the Grammar School, Leeds
June 18, 1874		||Stocks, Frederic, Sneal's Green House, Droitwich, Worcestershire
Nov. 17, 1887		Stocks, Herbert B., 25, Ferndale-road, Southdown-road, Liverpool
Mar. 5, 1885		Stocks, Joseph M., Ramsbottom Paper Mill Co., Ramsbottom, Lancashire
Dec. 3, 1885		Stoker, Henry, 5, Argyll Mount, Mansfield, Notts
April 17, 1879	Trans.	||Stokes, A. W., Vestry Hall, Paddington
Dec. 18, 1873		||Stone, Edward Daniel, Laboratory, 19, Lever-street, Piccadilly, Manchester
April 17, 1890		Stone, Frederick Richard M., 58, Upper Parliament-street, Liverpool
Dec. 2, 1875		||Stone, J. Harris, M.A., F.L.S., Barrister-at-Law, 3, Dr. Johnson's-buildings, Temple, E.C.
April 17, 1879		||Stone, William, M.A. Cantab, F.L.S., Oxford and Cambridge, Garrick, and Union Clubs, and Members Mansions, Victoria-street, S.W.
May 7, 1891		||Storey, James Ashburner, B.Sc., Warakamure, Matale, Ceylon
June 19, 1884		Stormouth, Thomas, Athol House, Clarence-road, St. Thomas, Exeter
Feb. 3, 1887		||Strangman, J. Pim, Sarno, Province of Salerno, Italy
May 7, 1885	Trans.	||Stuart, Charles M., M.A., St. Dunstan's College, Catford, S.E.
June 19, 1884		St. Stephen, Raynor, Tregenna House, 25, Fordwych-road, Brondesbury
Dec. 4, 1890	Trans.	||Sudborough, J. Joseph, B.Sc., Heidelberg Chemische Laboratorium der Universitats
Dec. 5, 1878	Trans.	||Suguira, Shigetake, care of Tokio Chemical Society, No. 7, Nishikouyacho, Tokio, Japan
June 16, 1887		Sulman, H. Livingstone, 13, Brewster-gardens, St. Quintin Park, W.
Feb. 16, 1888		Sumner, Robert Mason, c/o Messrs. Parke, Davis and Co., Detroit, Michigan, U.S.A.
April 21, 1887		Sutcliffe, Samuel, Mostyn, N. Wales
Feb. 3, 1887		||Sutherland, D.A., F.I.C., 2, Victoria Mansions, Westminster, S.W.
Feb. 21, 1884		Sutton, C. W., 19, Henley-road, Ipswich

Date of Election.		
April 19, 1860		Sutton, F., Laboratory, Bank Plain, Norwich
Mar. 4, 1886		Sutton, F. Napier, 6, Grosvenor-gardens, Willesden Green
June 3, 1875		Swan, Joseph William, M.A., Lauriston, Bromley, Kent
June 20, 1889		Swan, Robert, M. W., 15, Walmer-crescent, Glasgow
Dec. 5, 1889		Sworn, Sidney Augustus, 12, Beaumont-buildings, Oxford
Feb. 18, 1892		Sykes, James, 76, Lockwood-road, Huddersfield
Feb. 19, 1891		Sykes, M. Carrington, L.P.H. Lond., L.R.C.P. Lond. M.R.C.S. Eng., L.S.A. Lond., Sykeshurst, Barnley, Yorks.
May 16, 1889		Sykes, Walter J., M.D., 8, Nicosia-road, Wandsworth-common, S.W.
Feb. 19, 1891		Symes, K. Edward, Magdalen House, Bridport, Dorset
June 17, 1880		Symons, Brenton, 11, Parade, Truro, Cornwall
April 3, 1862	Trans.	Symons, William. Bilbrook, near Taunton
Dec. 17, 1874		||Symons, William Henry, F.R.M.S.. 130, Fellows-road, South, Hampstead, N.W.
Feb. 17, 1881	Trans.	||Takamatsu, T., Tokio University, Japan
Feb. 3, 1887	Trans.	Takamine, Jokichi, 907, Chamber of Commerce Buildings, Chicago Ill., U.S.A.
Feb 19, 1874		Tanner, Henry, Prof., 27, Mornington-crescent, Stanwick-road, West Kensington, W.
Feb. 21, 1884		Tarn, Albert, Mansion House-chambers, 20, Bucklersbury, E.C.
Dec. 4, 1890		Tate, Francis Henry, 9, Hackins Hey, Liverpool
June 16, 1881		Tate, George, Ph.D., College of Chemistry, Duke-street, Liverpool
Dec. 18, 1884	Trans.	||Tate, Walter, 43, Norwood Grove, Liverpool
May 15, 1890		Tate, William, Royal College of Science, South Kensington, S.W.
Dec. 5, 1867		Tatlock, Robert R., Observatory, 2, Mundonald-road, Glasgow
Dec. 2, 1875		Taylor, Andrew, 11, Lutton-place, Edinburgh
Feb. 7, 1878		Taylor, G. S., 13, Queen's-terrace, St. John's-wood, N.W.
Dec. 7, 1882		Taylor, G. Midgley, 27, Great George-street, Westminster
June 17, 1880		||Taylor, James, B.Sc., Government Metallurgist, Department of Mines, Sydney, New South Wales
June 18, 1891		Taylor, John, 15, Lucius-street, Torquay
April 19, 1888	Trans.	Taylor, John G., Orielton-terrace, Pembroke
Jan. 15, 1874		Taylor, R. L., 37, Mayfield-road, Alexandra Park, Manchester
June 4, 1885		Taylor, Rev. Charles Johnson, M.A., F.R.A.S., F.R.M.S., The Larches, Banstead, Surrey
Dec. 6, 1888		Taylor, William, China Sugar Refining Co., East Point, Hong Kong
April 4, 1878		||Tcherniac, Joseph, Ph.D., Thalstrasse 1, Freiburg ii Briesgau, Germany
April 17, 1879	Trans.	Teed, Frank L., D.Sc., 15, Victoria-street, S.W.
May 1, 1877		Terrill, William, 42, St. George's-terrace, Swansea
Feb. 15, 1881		Tervet, Robert, 54, Penshurst-road, South Hackney, E.
June 18, 1891		Tetley, Frederick, 3, Mannville-terrace, Horton-road, Bradford

Date of Election.		
Dec. 18, 1884		Thom, George, Dollar, N.B., and 48, Stanford-road, Victoria road, Kensington, W.
Nov. 17, 1859		‖Thomas, Andrew, 13, Hendley-street, Adelaide, South Australia
Dec. 7, 1871		‖Thomas, Charles, Woodcote, Stoke Bishop
Mar. 5, 1874		Thomas, Harry Edgcombe, Rockleaze Point, Clifton, Bristol
Feb. 18, 1875	Trans.	‖Thomas, Joseph William, Drumpellier, Brunswick-road, Gloucester
Feb. 5, 1863		‖Thompson, Beeby, 55, Victoria-road, Northampton
May 5, 1892		Thompson, George-de-Roos, 28, Treleth-road, Askham-in-Furness, Lancashire
Dec. 16, 1886		Thompson, W. Phillips, 95, Shrewsbury-road, Claughton, Birkenhead
Nov. 20, 1884	Trans.	Thompson, Charles, 15, Patshull-road, Kentish Town, N.W.
Dec. 17, 1885	Trans.	Thomson, Andrew, Ph.D., 10, Comly Bank, Bridgend, Perth
Mar. 4, 1886	Trans.	‖Thomson, Claude M., M.A., University College, Cardiff
Nov. 2, 1876	Trans.	Thomson, George C., 23, Kersland-terrace, Hillhead, Glasgow
April 15, 1858	Trans.	‖Thomson, John, 12, Lower Kennington-lane, S.E.
Jan. 18, 1872	Trans.	Thomson, John Millar, King's College, W.C.; and 53, Princes-square, Bayswater, W.
Jan. 18, 1872		Thomson, William, Royal Institution Laboratory, Manchester
Feb. 16, 1882	Trans.	Thorne, Leonard T., Ph.D., 8, Dynevor-road, Richmond, Surrey
Dec. 3, 1885		Thorne, Edward E. H., care of H. E. Thorne, Esq., Bridgetown, Barbadoes, West Indies
Nov. 20, 1890		Thornley, J., Brooks, junr., c/o Felton, Grimwash, and Co., Jeffcott street, Melbourne, Australia
Mar. 4, 1858		Thornthwaite, William, 416, Strand, W.C., and 14, Highbury Hill, N.
Mar. 15, 1888		Thornton, H. Belcher, 44, Salisbury-road, Wavertree, Liverpool
Dec. 3, 1891		Thorp, Walter, The Limes, Henry-road, New Barnet, N.
Feb. 1, 1866	Trans.	‖Thorp, William, B.Sc., 24, Crouch Hall-road, Crouch End, London, N.
Feb. 16, 1871	Trans.	†Thorpe, T. E., Ph.D., F.R.S., B.Sc., Royal College of Science, South Kensington, S.W.
May 7, 1891		Thonger, C. G. Freer, M.R.A.C., Colonial College, Hollesley Bay, Suffolk
Dec. 2, 1875	Trans.	Thresh, J. C., D.Sc., Medical Officer of Health, Chelmsford
Dec. 20, 1860	Trans.	Thudichum, John L. W., M.D., 11, Pembroke-gardens, W.
Dec. 2, 1880		Thwaite, B. H., Patent Office, 37, Victoria-street, Liverpool
Feb. 19, 1863	Trans.	Tichborne, C. R. C., LL.D., Ph.D., 15, North Great George-street, Dublin
Mar. 17, 1881	Trans.	Tiemann, Ferdinand, Ph.D., Berlin, W., Beudler-strasse, 18
June 1, 1865	Trans.	Tilden, William A., Prof., F.R.S., 77, Harborne-road, Edgbaston, Birmingham

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† Longstaff Medallist, 1881.

Date of Election.		
Dec. 5, 1889	Trans.	Tingle, J. Bishop, Ph.D., Gordon's College, Aberdeen
May 7, 1891		Tocher, James Fowler, A.I.C., 1, Chapel-street, Peterhead
June 20, 1853		Tomlin, Andrew, Valparaiso
June 2, 1864	Trans.	Tomlinson, Charles, F.R.S., 7. North-road, Highgate, N.
June 17, 1880	Trans.	Tompkins, H. K., B.Sc., 40, Alexandra-road, Gipsy Hill, S.E.
Feb. 21, 1884		Tompson, Frederick William, 1, Spring-terrace, Burton-on-Trent
June 21, 1877		Toms, Frederick Woodland, F.I.C., States Analyst, Jersey
Jan. 15, 1855		Tookey, Charles, Museum of Practical Geology, Jermyn-street, S.W.
Dec. 3, 1868	Trans.	Tosh, Edmund G., The Lund, Ulverston, Lancashire
Feb. 2, 1888		Townsend, Charles F., Belfast Corporation Gas Works, Ormeau-road, Belfast
June 16, 1887		Traphagen, Frank W., Ph.D., Prof. of Chemistry in the College of Montana, and in the Montana School of Mines, U.S.A., Deer Lodge, Montana
Feb. 18, 1892		Travers, Morris W., 2, Phillimore-gardens, Kensington, W.
Mar. 15, 1888		Trewby, Herbert, Langford Lodge, New Park-road, Brixton Hill, S.W.
June 16, 1881		Trigger, Oliver, Chemical Department, Royal Arsenal, Woolwich, S.E.
Nov. 15, 1888		Trinks, C. Heinrich, 40, Ainger-road, Primrose Hill, N.W.
May 5, 1892		Trobridge, Arthur, Langley, near Birmingham
Dec. 4, 1873		Truman, Edgar Becket, M.D., 31, Derby-road, Nottingham
Dec. 5, 1889		Tucker, Willis G., M.D., Albany, New York, U.S.A.
May 5, 1892		Tuer, Arthur Holt, Thornhill, Wigan, Lancashire
Dec. 2, 1886		Turner, Arthur, L.D.S. Ed., The Limes, Aylesbury
Dec. 6, 1888	Trans.	Turner, Charles, 225, Oxford-street, Manchester
Feb. 1, 1883	Trans.	Turner, Thomas, Mason College, Birmingham
Feb. 21, 1889	Trans.	Turpin, George Sherbrooke, M.A. (Cantab), D.Sc. (Lond.), Storey Institute, Lancaster
Dec. 15, 1892		Turton, Albert Henry, F.R.G.S., Ardleigh, Carlyle-road, Edgbaston, Birmingham, and Launceston, Tasmania
Feb. 2, 1871		Tustin, John Robt., The Elms, Merton Hall-road, Wimbledon, S.W.
June 2, 1870		Tustin, W. B., Lordings, 156, Denmark-hill, S.
Feb. 2, 1888	Trans.	Tutton, Alfred E., Royal College of Science, South Kensington
June 19, 1879		Tweedie, George R., 54, Hawley-square, Margate
May 5, 1892		Tweedie, Thomas Shortridge, The Moat, Anan
Dec. 2, 1886		Twining, Alfred H., The Knoll, Salcombe, Kingsbridge, South Devon
April 2, 1868		Tyndall, Dr. John, F.R.S., Hind Head House, Haslemere
Feb. 17, 1876		Typke, P. G. W., Ravenhurst, Morbiton Park, New Malden, Surrey
Dec. 7, 1876		Tyrer, Thomas, Stirling Chemical Works, Abbey-lane, Stratford
Dec. 3, 1885		Tyson, Thomas B., 21, Montague-street, Worthing
April 6, 1876		Udall, Thomas Bertram, Newcastle-under-Lyme, Staffordshire

Date of Election.		
Nov. 16, 1865		Umney, Charles, 50, Southwark-street, S.E.
Feb. 21, 1889		Underhill, Thomas J., 6, The Terrace, Royal Victoria Yard, Deptford, S.E.
June 3, 1869		||Vacher, Arthur, 9, Marlborough-hill, St. John's Wood, N.W.
Mar. 16, 1882		||Vacher, Francis, Birkenhead
Mar. 6, 1890		Valentin, Basil William, Ashton Brewery, Birmingham
Dec. 1, 1887		||Vargas, Vergara J. M., Laboratorio Central, Calle 13, No. 206, Bogota, Republic of Columbia, South America
Mar. 1, 1883		Vasey, S. A., Arncliffe, Leytonstone, Essex
Dec. 7, 1882		Vasey, Thomas E., 6, South-parade, Leeds
April 17, 1879	Trans.	Veley, Victor H., M.A., 22, Norham-road, and University, Museum, Oxford
Feb. 19, 1891		Velling, F. W. De, B.A., Upper Board Schools, Heckmondwike
May 6, 1881		Venable, Frank P., Ph.D., Chapel Hill, North Carolina
Jan. 17, 1889		Venis, Walter, M.R.C.S., L.S.A., D.P.H. Cantab., Benares, India
Jan. 18, 1872		Vincent, Charles W., F.R.S.E., F.C.S. of Berlin, Reform Club, Pall Mall, S.W. and Royal Institution, W.
May 16, 1889		Virtue, William, Abbey-street and Waterside Distilleries and Mills, Londonderry
Feb. 21, 1884		||Voelcker, Edward William, 39, Argyle-road, Kensington, W.
Jan. 17, 1884		||Voelcker, John A., Ph.D., 20, Upper Phillimore-gardens, Kensington, W.
April 17, 1862		Von Bose, C. Moritz, Messrs. Gehe and Co., Chemical Works, Dresden
April 4, 1889		||Voss, Walter Arthur, 159, Croydon-road, Anerley, S.E.
Nov. 19, 1885		Vulte, Hermann T., Ph.B., School of Mines, Columbia College, East 49th-street, corner of 4th-avenue, New York
Feb. 6, 1890		Wade, John, B.Sc. (Lond.), 15, St. George's Mansions, Bloomsbury, W.C.
June 7, 1888		Wade, Mark S., M.D., Victoria, British Columbia
Dec. 4, 1890		Wadsworth, George Henry, Fritham, near Lyndhurst, Hants
April 17, 1884		Wainwright, Howard, Ph.D., 22, West 46th Street, New York, City, U.S.A.
May 17, 1888		Wait, Frank Goodell, Geological Survey Department, Ottawa
Feb. 15, 1866	Trans.	Walenn, W. H., 9, Carleton-road, Tufnell Park, N.
Mar. 17, 1881		||Walker, Archibald, B.A., 8, Crown-terrace, Dowanhill, Glasgow
Feb. 2, 1865	Trans.	||Walker, J. F., M.A., 45, Bootham, Yorks; and Sidney College, Cambridge
Jan. 16, 1868		||Walker, Col. Alexander, R.A., Inspector-General of Ordnance, Calcutta

Date of Election.		
Dec. 5, 1889		Walker, Daniel, A.K.C., B.Sc., School of Mines, Ballarat, Victoria
Feb. 6, 1890		‖Walker, James, D.Sc., 5, Chepstow-place, Westbourne Grove
April 17, 1890		Walker, James S. H., c/o Mrs. Fleming, 19, Livingstone-place, Edinburgh
Dec. 6, 1888		Walker, J. T. Ainslie, The Laboratory, Rishton Paper Mills, near Blackburn, Lancashire
Feb. 17, 1881		Walker, Robert William, Bank Cottage, Edgworth, near Bolton
April 17, 1879		‖Walker, Thomas Hatfield, 1, Picton-place, Newcastle-on-Tyne
June 4, 1884		‖Wallace, Prof. Robert, The University, Edinburgh
Dec. 5, 1878	Trans.	‖Waller, Elwyn, Ph.D., School of Mines, Columbia College, cor. 49th-street, 4th-avenue, New York
Mar. 3, 1887		Wallis, Henry Weston, 8, Great Winchester-street, London, E.C.
Mar. 1, 1883		‖Walmsley, R. Mullineux, D.Sc., Heriot Watt College, Edinburgh
Dec. 6, 1888		Walrond, Edward Dalrymple, B.A., North Eastern Counties School, Burnard Castle, Durham
Dec. 9, 1869		Walton, Thomas, M.D., 10, Charlotte-street, Hull
Mar. 20, 1884		‖Walton, Thomas Ulrick, B.Sc., F.I.C., Colonial Sugar Refinery Co., Sydney, New South Wales
April 21, 1864		Ward, George, Buckingham-terrace, Headingley, Leeds
Dec. 1, 1887		Ward, John Septibo, 24, Newington, Liverpool
Dec. 3, 1891		Ward, Thomas Armistead, 62, King William-street, Blackburn
April 20, 1871		Ward, William, Sheffield Moor, Sheffield
Dec. 4, 1873	Trans.	Warden, C. J. H., Prof. of Chemistry, Medical College, Calcutta
May 20, 1875		Wardle, Thomas, F.G.S., Leek, Staffordshire
Mar. 19, 1863	Trans.	‖Warington, Robert, F.R.S., Harpenden, St. Alban
Dec. 7, 1871	Trans.	Warner, George Joseph, 41, Albert-road, Widnes
May 5, 1891		Warren, Cyprian A., 36, The Grove, Clapham-road, S.W.
Dec. 6, 1888		Warrick, Frederic Walmsley, 59, Great Ormond-street, W.C.
Nov. 17, 1887	Trans.	Warrington, Arthur Walley, University College of Wales, Aberystwith
Nov. 16, 1882		Waterfall, Charles J., 4, Queen's-square, Bristol
April 4, 1889		Waterhouse, Wm. John, B.Sc., Christ Church, Oxford
Mar. 15, 1888		Wates, Edward Arthur, Lingsugur, Deccan, India
Mar. 5, 1885		Watson, Charles, Walsden Chemical Works, near Todmorden
Jan. 18, 1872		Watson, David, D.Sc., The Broughton Copper Works, Salford, Manchester
June 16, 1887		‖Watson, Frederick Percy, 5, Beaumont-terrace, Lincoln
May 4, 1882		Watson, George, jun., 16, East Nelson-street, Whitevale, Glasgow
Mar. 1, 1883		‖Watson, Thomas Donald, 23, Cross-street, Finsbury, E.C.
Jan. 20, 1876	Trans.	‖Watson, W. H., Braystones, near Whitehaven, Cumberland
June 21, 1877		Watt, Alexander, c/o Messrs. Macfie and Sons, 34, Moorfields, Liverpool
Mar. 1, 1883	Trans.	Watts, Francis, Government Laboratory, St. John's, Antigua, West Indies

Date of Election.		
Feb. 1, 1872	Trans.	Watts, John, D.Sc., Chemical Laboratory, Museum-bdgs., Oxford.
Dec. 5, 1878		Watts, John I., Fir Grove, Winnington, Northwich
Dec. 6, 1888		Way, Edward J., F.I.C., c/o Transvaal Gold Exploration Co., Leydenberg, Pilgrims Rest, Transvaal
June 6, 1872		Weaver, Richard, C.E., The Sanitary Laboratory, 24, High Holborn, W.C.
Mar. 1, 1883	Trans	Webster, Charles Stuart, Malvern House, Redland, Bristol
Mar. 1, 1866		Webster, G. W., 33, Bridge-street-row, Chester
June 21, 1877		Webster, William, Glencot, Blackheath Park, Blackheath, S.E.
April 4, 1889		Weir, P. A., Surgeon-Major, M.B., Residency Surgeon, Nepal, *viâ* Bombay
Feb. 16, 1888		Welch, J. Cuthbert, Messrs. Simonds, The Brewery, Reading
Feb. 19, 1891		Wellington, Stephen N., M.I.C.E., Loretto House, Regent-road, Great Yarmouth, Norfolk
May 5, 1892		Wells, George I. J., F.I.C., Kinderton Lodge, Middlewich, Cheshire
June 19, 1884	Trans.	Wells, James S. C., Ph.D., Hackensack, New Jersey, U.S.A.
Feb. 6, 1890		Wells, S. Russell, B.Sc., 14, Girders-road, West Kensington
Feb. 18, 1888	Trans.	Werner, Emil A., 5, Church-avenue, Rathmines, Dublin
Dec. 17, 1874	Trans.	Wethered, Edward, 4, St. Margaret's-terrace, Cheltenham
Dec. 6, 1883		Wetzel, Henry A., Messrs. Parke, Davies, & Co., Box 470, Detroit, Michigan, U.S.A.
Mar. 4, 1886		Wertheimer, Julius, Merchant Venturers' School, Bristol
May 5, 1892		Whalley, Lawrence J. de Lancaster, 26, Park-place, Greenwich, S.E.
Dec. 6, 1888		Whieldon, Ernest William, 12, Bedford-road, Tottenham, N.
June 2, 1851		White, Alfred, F.L.S., West Drayton
Dec. 3, 1891		White, Henry, 80, London-road, Carlisle
Mar. 20, 1862		White, Leedham, 2, Lime-street-square, E.C.
April 4, 1889		White, John Tsawoo, M.A., F.I.C., Pyinmana, Upper Burmah
Feb. 5, 1885		Whitehead, Henry H., The Royal Brewery, Brentford
Dec. 5, 1889		Whitehouse, William, Albany House, Bradmore, Wolverhampton
Dec. 15, 1892		Whiteside, John Lowe, 51, Cannon-street, Bolton
Nov. 5, 1863		Whitfield, John, 113, Westborough, Scarborough
June 16, 1892		Whiteley, Fred., B.A., Barrow High School, Barrow-in-Furness
April 15, 1886	Proc.	Whiteley, R. Lloyd, University College, Nottingham
Dec. 15, 1881		Whitlock, James, Sunny Bank-villas, Oswaldtwistle, Lancashire
April 17, 1879		Whitaker, Thorp, Messrs. Ripley & Sons', Dye Works, Bradford, Yorkshire
Dec. 5, 1889		Whittam, Matthew, St. Peter's School, York
Dec. 5, 1889		Wigan, Basil P., North Cheshire Brewery Company, Macclesfield, and 43, Christ Church-square, Macclesfield
May 7, 1891		Wild, John, 28, Hyde-road, Woodley, Stockport
June 16, 1881		Wilkes, John Potter, Pinner's Hall, 54½, Old Broad-st., E.C.

Date of Election.		
Feb. 19, 1891		Wilkinson, David, the University, Dunedin, Otago, New Zealand
Dec. 17, 1885		Will, Wm. Watson, 1, St. Agnes-place, Kennington Park, S.E.
Feb. 19, 1891		Will, W., Ph.D., Beethhoven strasse, No. 1, Berlin, N.W.
Jan. 16, 1862	Trans.	‖Williams, C. Greville, F.R.S., F.I.C., Castlemaine, Oakhill-road, Putney, S.W.
April 1, 1875	Trans.	Williams, M. Whitley, 26, Elizabeth-street, Liverpool
June 21, 1883	Proc.	Williams, Rowland, Laboratory and Assay Office, 28, Pall Mall, Manchester
June 18, 1891		Williams, Seward W., c/o Seabury and Johnson, East Orange, New Jersey, U.S.A.
Dec. 5, 1872		‖Williams, Thomas, Chemical Laboratory and Assay Office, A, Queen Insurance-building, 10, Dale-street, Liverpool
April 19, 1888		Williams, T. Howell, 58, Lady Margaret-road, St. John's College-park, N.W.
Feb. 19, 1874	Trans.	‖Williams, W. Carlton, Firth College, Sheffield
Mar. 5, 1885		‖Williams, Walter Collingwood, 68, Grove-street, Liverpool
Feb. 7, 1878		Williams, W. J., 1412, Van Buren-street, Wilmington Del., U.S.A.
May 15, 1848	Trans.	‖Williamson, A. W., LL.D., F.R.S., High Pitfold, Haslemere
Dec. 4, 1874	Trans.	‖Williamson, Robert, c/o J. B. Williamson, Camp-terrace, North Shields
Mar. 4, 1886	Proc.	Williamson, Sidney, The Mason College, Birmingham
June 15, 1871		Willmore, Charles, Queenwood College, near Stockbridge, Hants
Dec. 5, 1872		Wills, Jos. Lainson, care of A. Wells, Esq., 8, Honeywell-road, Wandsworth-common, S.W., and 206, Albert-street, Ottawa, Canada
Dec. 2, 1875		Wills, Samuel Day, 11, Upper Belgrave-road, Clifton, Bristol
Dec. 5, 1889		Wilkie, John, M.D., 20, Buckingham-street, Strand, W.C.
Feb. 5, 1885	Trans.	Wilson. A. C., Chemical Laboratory, Exchange-buildings, Stockton-on-Tees
June 19, 1879		‖Wilson, Charles J., 19, Little Queen-street, Westminster
June 21, 1883	Trans.	‖Wilson, David, jun., Carbeth, Killearn, by Glasgow
Nov. 19, 1855		Wilson, G. F., F.R.S., Heatherbank, Weybridge-heath
Dec. 18, 1879		Wilson, J. Millar, Eddystone, Delaware Co., Pa., U.S.A.
April 1, 1875		‖Wilson, James, M.A., Barrister-at-law, 2, Essex-court, Temple and 23, Aberdeen-road, Highbury, N.
May 16, 1878		‖Wilson, James Henry, 6, Fenchurch-buildings, E.C.
Dec. 3, 1891		Wilson, John Henry, A.I.C., 29, Radford-street, Coventry
Dec. 7, 1871		Wilson, William John, 6, Malden-road, Watford
Dec. 17, 1885		Wilson, William M., The Limes, Hurstpierpoint, Hassocks Sussex
Nov. 20, 1890		Wilson, J. Mitchell, M.D., Medical Officer of Health, Doncaster
Dec. 5, 1889		Wiltshire, John, Maffra, Torquay

Date of Election.		
Feb. 5, 1874		Wiltshire, Thomas Pemberton, care of New York Tartar Company, 9th Street and Gowan's Canal, Brooklyn, New York
Dec. 18, 1884		Wilton, Thomas, The Gas Light and Coke Co., Beckton, North Woolwich
Dec. 1, 1887		Winder, Bartlett W., Sunny Bank House, 43, Broomhall-place, Sheffield
June 17, 1880		Wingham, Arthur, c/o H. G. Graves, 5, Robert-street, Adelphi, W.C.
Mar. 16, 1876		Winser, Percy James, Wyck House, Bebington, near Birkenhead
Nov. 19, 1885		Winstone, Arthur B., 7, Gray's Inn-square, W.C.
Mar. 2, 1857		Winstone, Benjamin, M.D., 100, Shoe-lane, E.C.; and 53, Russell-square, W.C.
Dec. 3, 1891		Winterton, A. W., 6, Linden-terrace, Rotherham
June 15, 1876	Trans.	Witt, Otto N., Ph.D., 33, Lindenallée, Westend, Charlottenburg, near Berlin
Dec. 5, 1867		Wood, Augustus A., 74, Cheapside, E.C.
April 4, 1889		Wood, Charles, 5, Wood-view, Bradford, Yorks
Jan. 19, 1860	Trans.	Wood, Charles Henry, Portland Villa, Drightstone-road, Addlestone, Surrey
Jan. 20, 1876		Wood, G. W., A.K.C., Metropolitan Board of Works, S.W.; an Riggindale-road, Streatham, S.W.
Dec. 7, 1876		Wood, John, Portland-villa, Troon, N.B.
Dec. 4, 1890		Wood, Sidney, 5, Woodview, Bradford, Yorkshire
Dec. 18, 1884		Wood, William H., B.A. (Oxon.), La Martinière, Calcutta
Feb. 19, 1880		Wood, W. H., 16, Church-place, Hopwood-lane, Halifax
Dec. 7, 1871	Trans.	Woodcock, Reginald C., The American and Continental Sanit Company, 636 to 642, West 55th-street, New York
Feb. 18, 1892		Woods, Hugh, 11, Archway-road, Highgate, London, N.
April 19, 1888		Woodward, James, B.A., F.I.C., B.Sc., 144, Osborne-road, Forest Gate, E.
Feb. 7, 1878		Woodland, John, Oaklands, Westhall-road, Lordship-lane, S.E.
April 4, 1889		Woolf, Mortimor, 16, Greville-place, N.W.
Dec. 6, 1859		Woosnam, Richard W., 139, Ladbroke Grove-road, Notting Hill, W.
Nov. 19 1885		Wormley, Theodore G., M.D., University of Pennsylvania, Department of Medicine, Philadelphia
Dec. 18, 1884		Worrall, J. Hall, F.I.C., 158, Ellesmere-road, Sheffield
Feb. 4, 1858	Trans.	Worsley, Philip J., Rodney Lodge, Clifton, Bristol
June 7, 1866	Trans.	Wright, Charles R. A., D.Sc., F.R.S., St. Mary's Hospital, Paddington, W.
Feb. 21, 1878	Trans.	Wright, Lewis Thompson, Buenos Ayres (New) Gas Co., Casill 765, 511, Calle Alsina, Buenos Ayres
Mar. 4, 1886		Wright, William T., 8, Grange-crescent, Sheffield

Date of Election.		
Feb. 4, 1864		Wrightson, John, Charford House, Salisbury
Feb. 19, 1891		Wyatt, Thomas M., 20, Queen's-square, W.C.
Dec. 2, 1880		Wyborn, John Middleton, 26, Widmore-road, Bromley, Kent
Nov. 20, 1884		Wyley, W. Fitzthomas, Wheatley-street, Coventry
May 7, 1885	Trans.	Wynne, W. P., D.Sc., Royal College of Science, South Kensington, and 35, Parson's-green, Fulham, S.W.
June 4, 1874	Trans.	Yates, Robert, 64, Park-street, Southwark
Dec. 16, 1886		Yoshida, H., Science College, Imperial University, Tokyo, Japan
Feb. 5, 1885		Young, Alfred C., 64, Tyrwhitt-road, St. John's, S.E.
Mar. 4, 1886		Young, Brougham, Home Lyn, Woodberry Down, London, N.
Mar. 15, 1877		Young, Frank W., High School, Dundee, and Woodmuir, West Newport, Fife, N.B.
Dec. 4, 1890		||Young, George, Ph.D., Firth College, Sheffield
June 21, 1877		Young, J. Rymer, 42, Sankey-street, Warrington
Feb. 5, 1874		Young, John, 2, Montague-terrace, Kelvinside, Glasgow
June 16, 1887	Trans.	Young, John William, B.Sc., B.A., Analyst's Office, Great Northern Railway Plant, Doncaster, and 25, Hall Gate, Doncaster
Feb. 16, 1882	Trans.	||Young, Sydney, D.Sc., University College, Bristol, and 13, Aberdeen-terrace, White Ladies'-road, Bristol
Nov. 6, 1873		Young, W. C., 22, Windsor-road, Forest-gate, Essex
April 4, 1878		Zingler, Maximilian, 19, Buckland-crescent, Belsize-park, N.W., and 16, Fenchurch-street, E.C.

FELLOWS OF THE SOCIETY WHO HAVE RECEIVED THE LONGSTAFF MEDAL—

1881.	T. E. Thorpe, F.R.S.
1884.	C. O'Sullivan, F.R.S.
1888.	W. H. Perkin, F.R.S.
1891.	F. R. Japp, F.R.S.

FOREIGN MEMBERS.

NUMBER NOT TO EXCEED FORTY.

Date of Election.	
May 18, 1876	Baeyer, Adolph von, F.R.S., University of Munich
Feb. 1, 1883	Beilstein, Prof. F., Ph.D., Technological Institute, St. Petersburg
Mar. 1, 1860	Berthelot, M., F.R.S., Collège de France, Paris
Feb. 2, 1888	Boisbaudran, Lecoq de, 36, Rue Prony, Paris
Feb. 1, 1842	Bunsen, R. W., Ph. D., F.R.S., University of Heidelberg
May 18, 1858	Cahours, Auguste, à la Monnaie, Paris
June 19, 1862	*Cannizzaro, S., Senato di Roma
Feb. 1, 1883	Cleve, Prof. P. T., Ph.D., University, Upsala, Sweden
May 18, 1876	Cooke, Josiah P., Harvard University, Cambridge, Massachusetts, U.S.
Feb. 1, 1883	Erlenmeyer, Prof. E., Ph.D., Frankfurt-on-Main
June 16, 1892	Fischer, Emil, Ph.D., University of Wurzburg
Feb. 1, 1883	Fittig, Prof. R., Ph.D., University, Strassburg
Mar 1, 1860	Fremy, Edmond, École Polytechnique, Paris
Nov. 4, 1844	Fresenius, C. Remigius, Ph.D., Wiesbaden
May 18, 1876	Friedel, C., École des Mines, Paris
May 3, 1866	Gibbs, Prof. Wolcott, Cambridge, Massachusetts, U.S.
June 16, 1892	Graebe, Carl, Ph.D., University of Geneva
Feb. 1, 1883	†Helmholtz, Prof. H. von, F.R.S., Neue Wilhelmstrasse, 16, Berlin, N.W.
Feb. 2, 1888	Hoff, Prof. J. H. van't, Ph.D., 103, Stadtonderskade, Amsterdam
June 19, 1862	Kekulé, Prof. A., F.R.S., University of Bonn
Feb. 2, 1888	Ladenburg, Prof. A., Ph.D., Kaiser Wilhelmstrasse, 43, Breslau
Feb. 2, 1888	Landolt, Prof. H., Ph.D., Königgrätzerstrasse, 123B, Berlin, W.
June 16, 1892	Lieben, Adolph, Ph.D., University of Vienna
June 19, 1862	Marignac, Jean Charles Galissard de, F.R.S., Geneva
Feb. 1, 1883	‡Mendeléef, Prof. D., Ph.D., University, St. Petersburg

* Faraday Lecturer, 1872.

† Faraday Lecturer, 1881.

‡ Faraday Lecturer, 1889.

Date of Election.	
Feb. 1, 1883	Meyer, Prof. Lothar, Ph.D., University, Wilhelmstrasse, 9, Tübingen, Germany
Feb. 1, 1883	Meyer, Prof. Victor, Ph.D., University of Heidelberg
Feb. 2, 1888	Nilson, Prof. L. F., Ph.D., Albano, Stockholm
June 19, 1862	Pasteur, L., F.R.S., École Normale, Paris
Mar. 1, 1860	Peligot, E., à la Monnaie, Paris
May 3, 1866	Rammelsberg, Prof. C. F., Berlin
June 16, 1892	Schiff, Hugo, Ph.D., University of Florence
June 16, 1892	Schlœsing, Th. Ph.D. Institute, Agromique, Paris
June 19, 1862	Stas, Prof. J. S., F.R.S., École Militaire, Brussels
May 18, 1876	Thomsen, Prof. Julius, Ph.D., University of Copenhagen
Feb. 2, 1888	Wislicen, Prof. Johannes, Ph.D., University, Leipzig

OF PERSONS WHO HAVE DELIVERED THE FARADAY LECTURE :—

1872. S. Cannizzaro, F.R S.
1875. Aug. Wm. von Hofmann, D.C.L., F.R.S.
1881. H. von Helmholtz, F.R.S.
1889. D. Mendeléef.

Harrison and Sons, Printers in Ordinary to Her Majesty, St. Martin's Lane, London, W.C.

PROCEEDINGS

OF

THE CHEMICAL SOCIETY.

Vol. IX. Nos. 118—130.

JANUARY—DECEMBER, 1893.

EDITED BY THE SECRETARIES.

LONDON:
GURNEY & JACKSON, 1, PATERNOSTER ROW.
1895

LONDON:
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DATES OF ISSUE OF THE MONTHLY NUMBERS OF THE JOURNAL OF THE CHEMICAL SOCIETY TO FELLOWS.

January	number was issued	2nd February.
February	,,	17th February.
March	,,	7th March.
April	,,	18th April.
May	,,	5th May.
June	,,	2nd June.
July	,,	5th July.
August	,,	4th August.
September	,,	2nd September.
October	,,	10th October.
November	,,	1st November.
December	,,	7th December.

LIST OF GRANTS MADE FROM THE RESEARCH FUND DURING THE YEAR.

£20 to Dr. Ruhemann for a study of the formation of pyridine derivatives from unsaturated acids.

£50 to Professor Dunstan for an investigation of the properties of paraffinic aldoximes.

£20 to Dr. Collie for the investigation of naphthalene derivatives from dehydracetic acid.

£10 to Mr. Easterfield for the investigation of citrazinic acid.

£40 to Mr. A. E. Tutton for the purchase of an instrument for the continuation of his crystallographic chemical work.

£20 to Messrs. A. G. Perkin and J. J. Hummel for the continuation of their investigations on the colouring principles contained in the Indian dye-stuff called Chay root.

£15 to Professor Meldola for the continuation of the study of the products of reduction of acetyl and benzoyl derivatives of the azonaphthols-azo-*p*-cresols.

£5 to Mr. T. S. Dymond for apparatus and chemicals for the investigation of certain changes in connection with the formation of aurochloric acid, auric chloride, and auroso-auric chloride.

£10 to Dr. J. Walker, for an investigation on the electrolytic products from camphoric acid.

£10 to Mr. S. U. Pickering for the determination of the heat of combination of certain substances in the solid and liquid condition.

£10 to Mr. A. R. Ling for an investigation on the acetyl and benzoyl derivatives of the sugars.

£5 to Dr. James Leicester for the study of the interactions of quinones and diamines.

£30 to Dr. W. H. Perkin, jun., for the continuation of his researches on the synthetical formation of unsaturated closed carbon chains.

£10 to Mr. C. H. Bothamley for the continuation of his investigations on the action of dyes on photographic plates, with respect to their sensitising action for rays of low refraugibility.

£30 to Professor W. R. Dunstan for further investigation of the properties of aldoximes.

LIST OF FELLOWS ELECTED DURING 1893.

Name.	Proposed.	Elected.
Bailey, Henry	April 20th	June 15th.
Baine, Laurence Augustus	February 16th	May 4th.
Baker, Julian L.	,, 2nd	,, ,,
Bateman, John	May 4th	June 15th.
Berridge, Frederick Edmund	November 2nd	December 7th.
Bone, William A.	February 2nd	May 4th.
Boone, William Thomas	January 19th	February 16th.
Bowman, Frederick Edmund	November 2nd	December 7th.
Briggs, Harry Fielden	,, ,,	,, ,,
Briggs, John Frederick	February 2nd	May 4th.
Brookbank, John Edwin	December 1st, 1892	February 16th.
Brooke, Edward	,, ,, ,,	,, ,,
Brown, Ralph Edward	March 16th	May 4th.
Browne, Frank	June 1st	December 7th.
Brunton, John Dixon	November 2nd	December 7th.
Buchanan, Joshua	March 16th	May 4th.
Burnett, William Robert	,, 16th	,, ,,
Burnham, John Charles	,, 2nd	,, ,,
Cahill, Robert S.	May 4th	June 15th.
Caines, Charles March	November 2nd	December 7th.
Cameron, James	March 2nd	May 4th.
Carswell, Thomas Petson	November 2nd	December 7th.
Chaney, Harry J.	,, ,,	,, ,,
Clayton, George	February 16th	May 4th.
Cocking, Allan Thomas	November 2nd	December 7th.
Coste, John Henry	April 20th	June 15th.
Craw, John A.	November 2nd	December 7th.
D'Albuquerque, John Pedrozo	December 15th, 1892	February 16th.
Davey, George	,, ,, ,,	,, ,,
Davies, D. O. Sydney	,, ,, ,,	,, ,,
Davy, S. W. M.	May 18th	June 15th.
Dickinson, H. W.	February 2nd	May 4th.
Dixon, Harry Williamson	March 2nd	,, ,,
Dreyfus, Charles	December 1st, 1892	February 16th.
Dufton, Samuel Felix	,, 15th, 1892	,, ,,
Dunnington, Francis P.	January 19th	,, ,,
Edwards, Thomas	March 2nd	May 4th.
Ellis, Charles Sondes	November 2nd	December 7th.
Elmore, Alexander Stanley	December 1st, 1892	February 16th.
Evans, Robert C. T.	March 16th	May 4th.
Forrester, Alexander M.	November 2nd	December 7th.
Fuller, Frederick George	January 19th	February 16th.
Gardner, John Addyman	February 2nd	May 4th.
Garnett, Henry	November 2nd	December 7th.
Gower, Alfred Roland	February 16th	May 4th.
Green, Arthur Henry	April 20th	June 15th.

Name.	Proposed.	Elected.
Grieve, William Hotten	November 2nd	December 7th.
Grimwood, Robert George	February 16th	May 4th.
Hadley, Harry Edwin	November 2nd	December 7th.
Hale, Henry Ormsby	June 15th	,, ,,
Hallen, Albin	January 19th	February 16th.
Hancock, Ernest Albert	May 18th	June 15th.
Harris, Harold	November 2nd	December 7th.
Heath, Arthur John	January 19th	February 16th.
Hesketh, William	November 2nd	December 7th.
Holthouse, Harold B.	,, ,,	,, ,,
Howitt, James John	May 18th	June 15th.
unt, Bertram	November 2nd	December 7th.
untly, George Nevill	December 1st, 1892	February 16th.
ones, Hedley Gordon	March 2nd	May 4th.
owitt, Hooper Albert D.	February 16th	,, ,,
Kaka, Sorabji M.	March 16th	,, ,,
Lamb, Edmund George	February 16th	,, ,,
Lambert, Wesley	January 19th	February 16th.
Leather, John Walter	May 18th	June 15th.
Lloyd, Herbert	February 16th	May 4th.
Luxmore, Charles M.	December 1st, 1892	February 16th.
Marsden, Frederick	January 19th	,, ,,
Martin, Alexander M.	May 4th	June 15th.
Martin, William J.	January 19th	February 16th.
Mason, James	February 16th	May 4th.
Mawer, William Frederick	November 2nd	December 7th.
McElroy, K. P.	May 18th	June 15th.
McGregory, J. Frank	February 2nd	May 4th.
McKerrow, Charles A.	May 4th	June 15th.
Mills, Charles	April 20th	,, ,,
Mole, Herbert Bloome	January 19th	February 16th.
Monson, Henry John	February 16th	May 4th.
Morgan, J. R.	November 2nd	December 7th.
Morton, Frederick	,, ,,	,, ,,
Mumby, Allan E.	February 2nd	May 4th
Murray, John Allan	,, ,,	,, ,,
Napier, John Watson	May 18th	June 15th.
Nasini, Raffaello	March 16th	May 4th.
Oates, William Henry	February 16th	,, ,,
Orndorff, William R.	May 4th	June 15th.
Orr, Alexander	April 20th	,, ,,
Owen, Robert Henry	December 1st, 1892	February 16th.
Parish, S.	February 16th	May 4th.
Payne, George F.	November 2nd	December 7th.
Platt, Charles	January 19th	February 16th.
Rees, George Percival	November 2nd	December 7th.
Reid, Thomas Anderson	,, ,,	,, ,,
Rintoul, William	February 2nd	May 4th.

Name.	Proposed.	Elected.
Ritchie, George	April 20th	June 15th.
Robbins, James Henry	February 2nd	May 4th.
Schidrowitz, Philip	November 2nd	December 7th.
Sessions, Wilfrid	May 4th	June 15th.
Shapley, Frederick	November 2nd	December 7th.
Sims, W. Edgar	,, ,,	,, ,,
Sorrell, Henry T.	April 20th	June 15th.
Styles, Robert Curling	November 2nd	December 7th.
Thackrah, James Robert	December 15th, 1892	February 16th.
Thompson, Frank E.	May 4th	June 15th.
Thompson, George Rudd	February 2nd	May 4th.
Thorpe, Jocelyn Field	November 2nd	December 7th.
Towers, John William	December 1st, 1892	February 16th.
Tyrer, Charles Thomas	,, 15th, 1892	,, ,,
Umney, John Charles	January 19th	,, ,,
Vandenburgh, Frank P.	February 16th	May 4th.
Vautin, Claude Thomas	May 18th	June 15th.
Waite, Charles E.	January 19th	February 16th.
Walden William Herbert	November 2nd	December 7th.
Walke, Willoughby	January 19th	February 16th.
Warmington, Edward A.	May 18th	June 15th.
Watson, A. F.	February 16th	May 4th.
Welchman, Frank Ernest	November 2nd	December 7th.
Whaley, Sydney	April 20th	June 15th.
Wheeler, William Ernest	December 1st, 1892	February 16th.
White, Henry C.	January 19th	February 16th.
White, William Gilchrist	June 15th	December 7th.
Whittaker, Thomas	April 20th	June 15th.
Wilkinson, John	March 16th	May 4th.
Winder, Edward Humphreys	June 15th	December 7th.
Wyndham, Stanley	November 2nd	,, ,,

FELLOWS DECEASED SINCE 1st JANUARY, 1893.

Name.	Elected.	Died.
Annal, James	April 4th, 1889	Dec. 8th, 1893.
Black, A. E.	„ 1st, 1880	
Blake, James	June 17th, 1886	June 28th.
Cannon, W. H.		
Carew, Russell	February 5th, 1863	March 19th.
Clarke, F. C. H., Col.	April 16th, 1868	August 27th.
Davies, Robert Higgins	December 18th, 1873	November.
Foster, William	January 18th, 1872	May.
Gale, Samuel.		
Heaton, C. H.	December 18th, 1854	September 11th.
Hind, H. R.	February 7th, 1878	April 17th.
Jones, John Hodgson-	December 15th, 1856	
Leibius, Adolph	„ 18th, 1879	June 19th.
Phillips, S. E.	„ 7th, 1882	May 23rd.
Rowney, Thomas Henry	March 21st, 1848	January 6th.
Scott, Charles K.	December 3rd, 1891	March.
Tustin, W. B.	June 2nd, 1870	May.
Tyndall, John, F.R.S.	April 2nd, 1868	December 4th.
Walton, Thomas	December 9th, 1869	1892.

TITLES OF PAPERS COMMUNICATED TO THE SOCIETY DURING 1893.

	Page in Proceedings.	Page in Transactions.
January 19*th.*		
93. Glucinum. Part I. The preparation of glucina from beryl. By John Gibson, Ph.D.	2	—
94. The determination of the thermal expansion of liquids. By T. E. Thorpe, F.R.S.	3	262
95. The determination of the thermal expansion and specific volumes of certain paraffins and paraffin derivatives. By T. E. Thorpe, F.R.S., and Lionel M. Jones, B.Sc.	4	273
96. The hydrocarbons derived from dipentene dihydrochloride. By William A. Tilden and Sidney Williamson	5	292
97. Sulphonic derivatives of camphor. By F. Stanley Kipping, Ph.D., D.Sc., and W. J. Pope	5	548
98. The preparation of dinitro-α-naphthylamine $[NH_2 : NO_2 : NO_2 = 1 : 2 : 4]$, from its acetyl and valeryl derivatives. By R. Meldola, F.R.S., and M. O. Forster, Ph.D.	7	—
99. Thionyl bromide. By P. J. Hartog and W. E. Sims	10	—
100. Desulphurisation of the substituted thioureas. By Augustus E. Dixon, M.D.	10	318
101. Salts of active and inactive glyceric acid: the influence of metals on the specific rotatory power of active acids. By Percy F. Frankland, F.R.S., and J. R. Appleyard	11	296
102. Dibromo-β-lapachone. By Samuel C. Hooker and A. D. Gray	13	434
103. The conversion of para- into ortho-quinone derivatives. By Samuel C. Hooker	13	—
104. The nitro-derivatives of phenolphthalein. By John A. Hall, M.Sc.	14	—
105. A method for the preparation of acetylene. By Morris W. Travers	15	—
February 2*nd.*		
106. The connection between the atomic weight of the contained metals and the magnitude of the angles of crystals of isomorphous series. By A. E. Tutton, Assoc. R.C.S.	27	337
107. The preparation of phosphoric oxide free from the lower oxide. By W. A. Shenstone and C. R. Beck	30	475

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108. Contributions to our knowledge of the aconite alkaloids. Part IV. On isaconitine (napelline). By Wyndham R. Dunstan and E. F. Harrison	31	443
109. Contributions to our knowledge of the aconite alkaloids. Part V. The composition of some commercial specimens of aconitine. By Wyndham R. Dunstan and Francis H. Carr	32	491
110. Synthesis of oxazoles from benzoin and nitriles. By Francis R. Japp, F.R.S., and T. S. Murray, D.Sc.	34	469
111. The action of nitrosyl chloride and of nitric peroxide on some members of the olefine series. By William A. Tilden and J. J. Sudborough	34	479
112. Piperazine. By W. Majert and A. Schmidt........	35	—

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114. The action of phosphoric anhydride on fatty acids. Part III. By F. Stanley Kipping, Ph.D., D.Sc. ..	40	452
115. Regularities in the melting points of certain paraffinoid compounds of similar constitution. By F. S. Kipping, Ph.D., D.Sc.	40	465
116. Some relations between constitution and physical constants in the case of benzenoid amines. By W. R. Hodgkinson and Leonard Limpach	41	—
117. Electrolysis of sodic ethylic camphorate. By J. Walker, D.Sc.	43	495
118. The hydrates of hydrogen chloride. By S. W. Pickering	45	—
119. A new base from *Corydalis cava*. By James A. Dobbie, M.A., D.Sc., and Alexander Lauder	45	485

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120. The lifework of Hermann Kopp. By T. E. Thorpe, D.Sc., F.R.S.	46	775

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121. The magnetic rotation and refractive power of ethylene oxide. By W. H. Perkin, Ph.D., F.R.S.	52	438
122. The origin of colour (including fluorescence). VII. The phthaleins and fluoresceins. By Henry E. Armstrong	52	—
123. The origin of colour. VIII. The limitation of colour to truly quinonoid compounds. Change of colour as indicative of change of structure, as in the case of alizarin. By Henry E. Armstrong ..	55	—

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124. Note on optical properties as indicative of structure. By Henry E. Armstrong	57	—
125. The origin of colour. IX. Note on the appearance of colour in quinoline derivatives and of fluoressence in quinine. By Henry E. Armstrong	63	—
126. The ethereal salts of glyceric acid, active and inactive. By Percy Frankland, Ph.D., B.Sc., F.R.S., and John MacGregor, M.A.	67	511
127. Formation of the ketone 2 : 6-dimethyl-1-ketohexaphane from dimethylpimelic acid. By F. Stanley Kipping, Ph.D., D.Sc.	68	—
128. Note on the interactions of alkali-metal haloids and lead haloids, and of alkali-metal haloids and bismuth haloids. By Eleanor Field, Assistant-Demonstrator in Chemistry, Newnham College, Cambridge	69	540
129. An isomeric form of benzylphenylbenzylthiourea. By Augustus E. Dixon, M.D.	70	538
130. A new atomic diagram and periodic table of the elements. By R. M. Deeley	70	852

March 16*th.*

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131. The limits of accuracy of gold bullion assaying, and the losses of gold incidental to it. By T. K. Rose	73	700
132. The volatilisation of gold. By T. K. Rose	75	714
133. Note on the boiling point of nitrous oxide at atmospheric pressure, and on the melting point of solid nitrous oxide. By William Ramsay, F.R.S., and John Shields, Ph.D., B.Sc.	76	833
134. The isomerism of paraffinic aldoximes. By Wyndham R. Dunstan and T. S. Dymond	76	—
135. The mineral waters of Askern, in Yorkshire. By C. H. Bothamley	78	685
136. Note on the distribution of acidic and alkalinic radicles in a solution containing calcium, magnesium, carbonates, and sulphates; and on the composition of mineral waters. By C. H. Bothamley	79	696
137. A magnesium compound of diphenyl. By W. R. Hodgkinson	80	—
138. Note on acetanhydrocitric acid. By Felix Klingemann	81	699
139. The dissolution of gold in a solution of potassium cyanide. By R. C. Maclaurin, B.Sc.	81	724

April 20*th.*

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2. The interaction of alkali cellulose and carbon disulphide: cellulose thiocarbonates. By C. F. Cross, E. J. Bevan, and C. Beadle	108	—

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3. Sulphocamphylic acid. By W. H. Perkin, jun.	109	—
4. Magnesium diphenyl. By Lothar Meyer	111	—
5. The formation of pyridine derivatives from unsaturated acids. By S. Ruhemann, Ph.D.	112	259
6. Chlorinated phenylhydrazines. Part II. By J. T. Hewitt, Ph.D.	112	868
7. The oxidation of tartaric acid in presence of iron. By H. G. H. Fenton, M.A.	113	—
8. The inertness of quicklime. By V. H. Veley	114	821
9. The products of the interaction of tin and nitric acid. By C. H. H. Walker	114	845
10. Interaction of thiourea and some haloid derivatives of fatty acids. By Augustus E. Dixon, M.D.	115	815

May 4th.

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11. The hydrates of sodium, potassium, and lithium hydroxides. By S. W. Pickering	118	890
12. Detection of arsenic in alkaline solution. By John Clark, Ph.D.	119	—
13. Improvements in Reinsch's process. By John Clark, Ph.D.	119	886
14. The action of light in preventing putrefactive decomposition and in inducing the formation of hydrogen peroxide in organic liquids. By Arthur Richardson, Ph.D.	121	1109
15. The supposed saponification of linseed oil by Dutch white lead. By J. B. Hannay, F.R.S.E., and Arthur E. Leighton	122	—
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18. The influence of moisture in promoting chemical action. Preliminary Note. By H. Brereton Baker, M.A.	129	—
19. The genesis of new derivatives of camphor containing halogens by the action of heat on sulphonic chlorides. By F. Stanley Kipping, Ph.D., D.Sc., and W. J. Pope	130	—

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20. Studies on the formation of ozone. II. By W. A. Shenstone and Martin Priest	141	938
21. The relative strengths or "avidities" of some compounds of weak acid character. By John Shields, D.Sc., Ph.D.	144	—
22. The boiling points of homologous compounds. Part I. Simple and mixed ethers. By James Walker, Ph.D., D.Sc.	145	—

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23. The conditions determinative of chemical change. By Henry E. Armstrong	145	—
24. The nature of depolarisers. By Henry E. Armstrong	148	—

June 1*st*.

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25. Azo-compounds of the ortho-series. By R. Meldola, E. M. Hawkins, and F. B. Burls	161	923
26. The production of a fluorescein from camphoric anhydride. By J. Norman Collie, Ph.D., F.R S.E.	163	961
27. Researches on the terpenes. III. The action of phosphorus pentachloride on camphene. By J. E. Marsh and J. A. Gardner	163	—
28. The composition of a specimen of jute fibre produced in England. By Andrew Pears, jun.	165	964
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30. Ortho-, para- and peri-disulphonic derivatives of naphthalene. By Henry E. Armstrong and W. P. Wynne	166	—
31. Supplementary notes on madder colouring matters. By E. Schunck, Ph.D., F.R.S., and L. Marchlewski	169	969
32. The constitution of rubiadin glucoside and of rubiadin. By L. Marchlewski	169	1137

June 15*th*.

	Page in Proceedings.	Page in Transactions.
33. Contributions to our knowledge of the aconite alkaloids. Part VI. Conversion of aconitine into isaconitine. By Wyndham R. Dunstan, M.A., F.R.S., and Francis H. Carr	171	991
34. Contributions to our knowledge of the aconite alkaloids. Part VII. Some modifications of aconitine aurichloride. By Wyndham R. Dunstan, M.A., F.R.S., and H. A. D. Jowett	172	994
35. Note on the stereoisomerism of nitrogen compounds. By S. U. Pickering	173	1069
36. A study of the properties of some strong solutions. By S. U. Pickering	174	998
37. Studies on citrazinic acid. By W. J. Sell and T. H. Easterfield	174	1035
38. The essential oil of hops. Preliminary Notice. By Alfred C. Chapman	177	—
39. The sulphides and polysulphides of ammonium. By W. P. Bloxam	178	—
40. Sarcolactic acid obtained by fermentation of inactive lactic acid. By Percy Frankland, F.R.S., and J. MacGregor, M.A.	180	1028

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PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

No. 118. Session 1892–93.

January 19th, 1893. Professor A. Crum Brown, President, in the Chair.

Messrs. James W. Rodger and Morris W. Travers were formally admitted Fellows of the Society.

Ordinary certificates were read for the first time in favour of Messrs. William Thomas Boone, 6, Mount Pleasant Road, Tottenham; Frederick George Fuller, 19, Brunswick Square, W.C.; Arthur John Heath, 1, Grove Villas, Redland, Bristol; Wesley Lambert, 55, Plumstead Common Road, Plumstead; Herbert Bloome Mole, Hillside, Shepton Mallet; Fred. Marsden, Bangor, North Wales; Charles Platt, Buffalo, N.Y., U.S.A.; Charles Henry Southwell, Boston; John Charles Umney, 50, Southwark Street, London; Herbert Wills, LL.D., Fern Bank, Halliwell, near Bolton.

Certificates of the following candidates, proposed by the Council under Bye-law I, para. 3, were also read:—Francis P. Dunnington, Charlottesville, Va., U.S.N.A.; Albin Haller, 14, Rue de Metz, à Nancy; William J. Martin, jun., M.D., Charlottesville, Va., U.S.N.A.; Charles E. Wait, Knoxville, Tenn., U.S.N.A.; Willoughby Walke, Fort Munroe, Va., U.S.N.A.; Henry C. White, Athens, Georgia, U.S.N.A.

Address to M. Pasteur.

On behalf of the Chemical Society of London, we, the President and Officers, beg to tender to you, Mons. Pasteur, our most hearty congratulations on the occasion of your 70th birthday, and to express the fervent hope that for many years to come you may continue to exert your beneficent influence over that department of scientific enquiry so peculiarly your own.

It is 30 years since you were elected a Foreign Member of our Society; and at that time your work as a pioneer was already completed. By your study of the tartaric acids and by the discovery of methods of resolving the optically inactive acid into its active components, you laid the foundation of the modern theories of geometrical isomerism which during recent years have served so largely to promote new and important experimental enquiries; and you placed weapons in the hands of chemists which have retained their usefulness up to the present day and which over and over again have been wielded with marvellous effect.

Furthermore, your studies on fermentations—apart from their industrial importance, which is immense—have served to promote enquiries of the utmost value to mankind and their influence must ever be felt.

Few men have been able to present to the world so imperishable a record of services rendered to humanity; and your name is one which must ever be enshrined in loving memory in the records of time.

We are, Sir, in deepest respect,

Your most faithful colleagues,

A. Crum Brown.
T. E. Thorpe.
Henry E. Armstrong.
John M. Thomson.
R. Meldola.

(*Presented December* 27, 1892.)

Of the following papers those marked * were read:—

***93. "Glucinum. Part I. The preparation of glucina from beryl." By John Gibson, Ph.D.**

Of the many methods proposed for the preparation of glucina from beryl, only a few give satisfactory results, and none of them can be applied easily on a large scale. The percentage of glucinum in beryl is small and it is therefore necessary to work up large quantities of this very hard mineral in order to obtain a stock of glucina sufficient for the purposes of investigation. Hitherto it has been found necessary to grind the mineral to a very fine powder as a preliminary to its complete decomposition by the usual agents employed in the case of refractory silicates.

The present communication gives an account of a method by which a kilogram or more of beryl may be worked up at a time in an easy manner, and without being ground to a fine powder, the whole of the glucina contained in the beryl being obtained very quickly in a nearly pure condition, and, in particular, nearly free from alumina and oxide of iron. The method is based on the different behaviour of the fluorides of aluminium, iron and glucinum when heated together, it being found that if coarsely ground beryl be heated in an iron vessel with six parts of ammonium hydrogen fluoride, the mineral is completely decomposed at a temperature below a red heat, the soluble aluminium fluoride at first formed being rendered insoluble in water if the heating be sufficiently prolonged, while the bulk of the fluorides of iron are decomposed and converted into ferric oxide, the glucinum fluoride remaining soluble in water.

A new method for the perfect removal of the last traces of iron from the crude glucina is also described, based on the observation that in the presence in solution of a large excess of a lead or mercuric salt the precipitation of the lead or mercury as sulphide by ammonium sulphide effects by mass action the complete precipitation of the iron.

*94. "The determination of the thermal expansion of liquids." By T. E. Thorpe, F.R.S.

The author describes improvements in the ordinary dilatometrical method of determining the thermal expansion of liquids. The main improvement consists in the adoption of the simple device now employed in the construction of standard mercurial thermometers, *i.e.*, in enlarging the bore of the tube at some point in the stem, thus forming a small bulb or cavity in order that the position of the 0° and 100° points may be determined on each instrument irrespectively of its range without unduly increasing the length of the stem or diminishing the width of the scale divisions. The length of the stem is thus considerably shortened, so that both it and the thermometer can be wholly immersed in a bath of moderate size; this makes it possible to take successive readings with much greater rapidity than formerly and obviates the necessity of correcting for the emergent columns of the two instruments, thereby diminishing the time and labour required both in the actual observations and the subsequent reductions.

In the paper, the mode of constructing and calibrating the dilatometers is fully described, also the mode of cleaning and filling them, the baths used in heating them, and the method of making the observations.

DISCUSSION.

Professor RAMSAY having advocated the method of heating by means of the vapours of liquids boiling under regulated pressures which had been largely used by Professor Young and himself in place of baths of heated liquid, Professor THORPE pointed out that the time occupied and labour involved in making the observations was small in comparison with that involved in their reduction, and that, for the purposes of calculation, it was very convenient to take readings at definite intervals of temperature; this, he thought, could be more readily done by means of a liquid bath. Professor RAMSAY said that it was equally easy to vary and adjust the temperature of vapour baths, but admitted that such were not well adapted for use at low temperatures.

***95. "The determination of the thermal expansion and specific volumes of certain paraffins and paraffin derivatives." By T. E. Thorpe, F.R.S. and Lionel M. Jones, B.Sc.**

The authors give the data relating to a number of substances, and discuss the results particularly in relation to Lossen's deductions. Their results are summarised in the following table:—

	B. p.	Density at 0°.	Density at b. p.	Specific volume.		
				Obs.	Kopp.	Lossen.
	° C.					
Pentane	36·3	0·64750	0·61200	117·6	121·0	117·2
Isopentane	30·4	0·63872	0·60857	118·3	121·0	117·2
Isohexane	62·0	0·67660	0·61744	139·3	143·0	139·8
Amylene	36·4	0·68499	0·64759	108·1	110·0	109·7
Isoprene	35·8	0·6912	0·6545	103·9	99·0	102·3
Trimethyl carbinol	82·2	0·80716	0·7194	102·8	106·8	102·0
Dimethyl ethyl carbinol	101·3	0·8269	0·7248	121·4	128·8	123·4
Inactive amyl alcohol	131·4	0·82536	0·71362	123·3	128·8	123·4
Active amyl alcohol	128·7	0·83302	0·72111	122·0	128·8	123·4
Methyl ethyl ketone	80·6	0·82961	0·74422	96·7	100·2	95·1
Methyl propyl ketone	101·7	0·82585	0·72568	118·5	122·2	117·2
Diethyl ketone	102·1	0·8335	0·7306	117·7	122·2	117·2
Propionic anhydride	168·6	1·0336	0·8431	154·2	53·2	150·3
Methyl sulphide	37·5	0·87022	0·82567	75·1	77·6	75·8
Isobutylene bromide	149·6	1·7675	1·5147	142·6	144·2	142·8

It will be seen that, with the exception of that for propionic anhydride, all the observed numbers differ considerably from those calculated by means of Kopp's values. On the other hand, they show in the main a fairly satisfactory agreement with the values calculated by Lossen's formula. It is noteworthy that the observed value for acetic anhydride deduced from Kopp's experiments, viz., 109·9, is also greatly in excess of the value calculated by Lossen's formula. If, however, Lossen's slightly higher value, *e.g.*, $CO_2H = 10·74$, as given for the oxalic ethers be taken, values for these oxides are obtained which are in better agreement with the results of observation; thus,

	Observed.	Calculated.
Acetic anhydride......	109·9	108·4
Propionic anhydride...	154·2	154·4

*96. "The hydrocarbons derived from dipentene dihydrochloride." By William A. Tilden and Sidney Williamson.

The dihydrochloride $C_{10}H_{16}2HCl$ (m. p. 50°), prepared by the interaction of moist hydrogen chloride and dextro- or levo-rotatory turpentine, is known to be identical with the dihydrochloride formed from dextro- or levo-rotatory citrene (limonene) or from inactive "dipentene." The hydrocarbon obtained by removing the elements of hydrogen chloride from this compound has been supposed to consist essentially of one compound, dipentene, but in view of results obtained in oxidising this substance (Trans., **53**, 880), a further examination of the product seemed desirable.

The authors find, by direct experiment, that, like dextrolimonene, when oxidised by nitric acid, levolimonene and pure dipentene afford neither toluic nor terephthalic acid. The product obtained by heating dipentene dihydrochloride with aniline, however, is a mixture of hydrocarbons, of which dipentene is perhaps the most abundant constituent, but is accompanied by large proportions of cymene, terpinene, terpinolene and a small quantity (about 2·5 per cent.) of a saturated paraffinoid hydrocarbon boiling at about 155°. The toluic acid obtained in the former experiments (*loc. cit.*), therefore, is not to be regarded as formed from dipentene but from the cymene present, and to some extent from the terpinene, which, when oxidised by nitric acid, yields a smaller but appreciable amount of this acid.

The paper concludes with a short discussion of some theoretical points having reference chiefly to the formulæ which have been ascribed to pinene and camphene.

*97. "Sulphonic derivatives of camphor." By F. Stanley Kipping, Ph.D., D.Sc., and W. J. Pope.

The study of these compounds has been entered upon, in order, if possible, to throw light on the changes which attend the formation of acetylorthoxylene, &c., from camphor and sulphuric acid (*cf.* Armstrong and Kipping, Trans., 1893, 75).

The preparation of camphorsulphonic acid has been attempted by several chemists, but up to the present with a uniform lack of success; the authors found, however, that it may be prepared by the interaction of anhydrosulphuric acid containing about 15 per cent. of anhydride and dry powdered camphor: very vigorous action ensues on adding the acid, much heat being liberated, and sulphur dioxide is evolved; on pouring the acid liquid on to ice, very little camphor separates. To purify the product, the sodium salt prepared from the solution is submitted to the action of phosphorus pentachloride, and, by a somewhat tedious process, *camphorsulphonic chloride*, $C_{10}H_{15}O\cdot SO_2Cl$, is obtained in colourless crystals which are a mixture of optically different modifications very difficult to resolve. The isolation of a pure sulphonic derivative of camphor in the manner described is by no means easy, several other products being simultaneously formed in large quantities.

According to Marsh and Cousins (Trans., 1891, 967) camphorsulphonic acid is not formed by the interaction of chlorosulphonic acid and camphor dissolved in chloroform. The authors find, however, that camphor is readily sulphonated by chlorosulphonic acid in absence of a solvent; the action proceeds without any noticeable carbonisation or evolution of sulphur dioxide. The sulphonic chloride prepared from this product, like that already referred to, is a mixture of optically different isomerides.

What appears to be the pure dextrorotatory form of the sulphochloride crystallises in tetrahedra melting at 136—137°.

Prior to the isolation of the active chloride, the following derivatives were prepared from a nearly pure inactive product:—

Camphorsulphonamide, $C_{10}H_{15}O\cdot SO_2NH_2$, obtained by the action of aqueous or alcoholic ammonia on the sulphonic chloride: six-sided, transparent, colourless, monosymmetric plates ($a : b : c = 0{\cdot}821 : 1 : 1{\cdot}047$; $\beta = 81° 4'$), melting at 134—135°.

Camphorsulphonic acid, $C_{10}H_{15}O\cdot SO_3H$. The sulphonic chloride is slowly hydrolysed by boiling water; the acid crystallises in arborescent forms, and is very deliquescent; it melts at 58—60°. Its aqueous solution dissolves zinc or magnesium with evolution of hydrogen; a series of well-defined salts has been obtained.

The action of anhydrosulphuric acid on the haloid derivatives of camphor is much less violent than when camphor itself is employed. Anhydrosulphuric acid dissolves bromocamphor with slight rise of temperature, giving an amber coloured solution of sulphonic acid, completely soluble in water. The sodium salt, prepared in the usual way, gives on treatment with phosphorus pentachloride a *bromo-*

camphorsulphonic chloride, $C_{10}H_{14}BrO{\cdot}SO_2Cl$, which can be separated from a quantity of dark oil accompanying it by suitable methods. The purified substance crystallises from chloroform in magnificent octahedra, melting at 136—137°. The crystals are colourless and transparent, and may be readily obtained several centimetres in diameter.

Marsh and Cousins (Trans., 1891, 974) have prepared a sulphonic chloride of similar composition by the action of chlorosulphonic acid on bromocamphor. They describe the substance as "a black, semi-crystalline solid." A repetition of their work showed this substance to be merely an impure form of the one now described; the identity of the chlorides from the two sources having been established by the ordinary means and by crystallographic measurements. The chloride has a high rotatory power—$[\alpha]_D =$ about $+128°$ in chloroform solution.

Bromocamphorsulphonic acid, $C_{10}H_{14}BrO{\cdot}SO_3H$, is readily obtained by boiling the chloride with water. It forms large, pyramidal shaped crystals, which are somewhat hygroscopic and very soluble in water. The anhydrous acid melts at 195—196°; the aqueous solution dissolves zinc and magnesium. The acid is described by Marsh and Cousins as a "black tarry mass." The salts generally crystallise well, and have been examined crystallographically. The *sulphonamide* crystallises in long, silky needles, and melts at 144—145°.

Chlorocamphorsulphonic chloride, $C_{10}H_{14}ClO{\cdot}SO_2Cl$, obtained in an analogous manner, crystallises in massive, colourless octahedra, indistinguishable in appearance from the bromo-derivative. It melts at 123—124°. $[\alpha]_D =$ about $+110°$ in chloroform solution. This substance was described by Marsh and Cousins (*loc. cit.*) as a "microcrystalline, black solid."

On boiling with water the chloride yields *chlorocamphorsulphonic acid*, $C_{10}H_{14}ClO{\cdot}SO_3H$, which crystallises in hygroscopic, rectangular plates; it affords a series of well-defined salts.

The *ammonium* salts of bromo- and chloro-camphorsulphonic acids are especially interesting from a crystallographic point of view. Possessed of optical activity when in solution, they crystallise in monosymmetric prisms exhibiting hemimorphism and showing strongly marked pyroelectrical properties.

The further investigation of these sulphonic derivatives, and of the bye-products which are formed in their preparation, is in progress.

98. "The preparation of dinitro-α-naphthylamine [$NH_2 : NO_2 : NO_2 = 1 : 2 : 4$], from its acetyl and valeryl derivatives." By R. Meldola, F.R.S., and M. O. Forster, Ph.D.

A simple method of preparing this compound was described by one of the authors in a note published in 1886 (*Ber.*, 19, 2683); other investigators having experienced difficulties, or having altogether failed, in obtaining it by this method, we have been led to reinvestigate the subject, and can confirm the practicability of the process formerly described. The difficulty experienced by other workers has, no doubt, arisen from using the hydrolysing agent (sulphuric acid) either too strong or too weak. The following details may, therefore, be found useful:—

The α-acetnaphthalide is nitrated in glacial acetic acid in the usual way, using a little more than the theoretical quantity of fuming nitric acid. It will be found advantageous to divide the operation into two stages, adding one half of the nitric acid to the well-cooled solution in the first place and then allowing to stand over night, so that the mixed mononitro-α-acetnaphthalides are formed at a low temperature. The solution is warmed the following day in a water-bath till the crystalline mononitro-derivatives have dissolved up, when the other half of the nitric acid is added. The dinitro-derivative soon forms, and the solution begins to solidify while still hot. The whole mass forms a pulp of crystals when cold. The mother liquor being squeezed out, the crystals are washed with water, drained and purified by being boiled up with alcohol and allowed to cool. Very little of the dinitro-α-acetnaphthalide is lost by this treatment, as the compound is but slightly soluble in cold alcohol. Resinous impurities, which interfere with the purity of the subsequent product, are removed by the alcohol. The alcoholic extraction may be repeated if necessary. The purified dinitro-derivative, when dry, is easily hydrolysed by heating to the temperature of boiling water for about an hour with a mixture of equal volumes of strong sulphuric acid and water (50 grams dinitro-compound, 150 c.c. strong sulphuric acid and 150 c.c. of water). The product is poured into cold water, collected, washed and crystallised from somewhat dilute alcohol with the addition of animal charcoal till it has the correct melting point (237° from alcohol).

While engaged in these experiments, it appeared to be of interest to ascertain the effect of lighter and heavier acid radicles in facilitating or retarding hydrolysis by sulphuric acid. It was found that *formonaphthalide* could not be converted into a dinitro-derivative in glacial acetic acid. Even when a large excess of nitric acid is used, the product is mononitroformonaphthalide. Nitrogen found: (I) 13·08, (II) 12·99, per cent.; calculated for mononitro-derivative, 12·96 per cent.; calculated for dinitro-derivative, 16·09 per cent.

It evidently consists of a mixture of isomerides, as no compound of a definite melting point was isolated; much resin is also formed during the nitration.

Valeronaphthalide was prepared by boiling α-naphthylamine with excess of "anhydrous valerianic acid" (Hopkin and Williams) for at least 36 hours. The product fuses to an oil under hot water, and is purified by successive agitation with hot water, dilute ammonia, dilute chlorhydric acid (to remove unaltered naphthylamine) and finally with water. The resinous cake thus obtained gradually becomes a crystalline mass on standing in the cold. One or two crystallisations from dilute alcohol render the compound sufficiently pure for nitration. A specimen was purified for analysis by repeated alternate crystallisations from alcohol and benzene. The pure compound forms white, silky needles melting at 125—126° and gradually becoming violet on exposure to air and light; on analysis, it was found to contain 78·95 carbon, 7·72 hydrogen and 6·25 nitrogen, the values calculated for $C_{10}H_7{\cdot}NH{\cdot}C_5H_9O$ being 79·29 carbon, 7·48 hydrogen, 6·17 nitrogen.

The nitration is easily effected by dissolving the substance in glacial acetic acid and at once adding to the cold solution a little more than the theoretical quantity of fuming nitric acid diluted with an equal volume of glacial acetic acid. It is best to start with a cold *saturated* solution of the valeronaphthalide in glacial acid. After adding the nitric acid, the solution may be allowed to stand for some hours in the cold and then warmed to 70—80° for about 15 minutes The nitration is complete by that time, the dinitro-derivative slowly separating out on cooling. The crystalline cake thus obtained is first washed with water and then purified by crystallisation from alcohol, in which the dinitro-derivative is much more soluble than the corresponding dinitro-acetnaphthalide. If, during nitration, decomposition sets in with effervescence, the contents of the vessel must be at once cooled, or the product will be found to be much contaminated with resinous matter, and the yield will be considerably diminished. Two experimental batches were lost by neglecting this precaution.

Dinitrovaleronaphthalide, when purified by crystallisation from alcohol and glacial acetic acid successively, forms pale, straw-coloured, silky needles, having a melting point of 218°. It is rapidly converted into dinitro-α-naphthol by boiling with dilute alkali. A purified specimen was analysed with the following results:—Carbon 57·03, hydrogen 4·96, nitrogen 13·11. The values calculated for $C_{10}H_5(NO_2)_2{\cdot}NH{\cdot}C_5H_9O$ being:—Carbon 56·78, hydrogen 4·73, nitrogen 13·24.

This compound appears to be more readily hydrolysed than the acetyl derivative. The proportions of acid, water and substance found effective were:—30 grams dinitro-compound, 600 grams strong sulphuric acid, 60 grams water; after heating for 10—15 minutes in a water-bath, the product is precipitated by pouring the mixture into cold water and treated as in the case of the acetyl derivative. We have not made a series of exact comparisons between the acetyl and valeryl derivatives with the object of measuring the relative rates of hydrolysis. It appears, however, from our experiments, that valeryl is more easily removed than acetyl without deeper decomposition of the dinitro-derivative into resinous products, and this seems to point to the conclusion that there is an advantage in starting with a naphthalide containing a radicle *heavier* than acetyl. On the other hand, glacial acetic acid is so much cheaper than its higher homologues, that from an economical point of view the dinitro-α-acetnaphthalide will be found the most advantageous compound to employ for the preparation of dinitro-α-naphthylamine. It is proposed to prepare a large quantity of the latter by the method described, with the object of extending our knowledge of the metadi-derivatives of naphthalene, for the preparation of which the metadinitronaphthalene, obtained by the diazo-method, will, it is hoped, furnish a convenient source. We have received valuable assistance in conducting these experiments from Messrs. E. M. Hawkins and F. B. Burls, two of the third-year students of the Finsbury Technical College, to whom we wish to express our thanks.

99. "Thionyl bromide." By P. J. Hartog and W. E. Sims.

The authors have prepared thionyl bromide by the interaction of sodium bromide and thionyl chloride, obtaining it in the form of a deep crimson liquid of the relative density 2·68 at 18° C.; the colour is, however, possibly due to the presence of a small quantity of certain sulphur bromides: though their amount is small, hitherto it has not been found possible to deprive thionyl bromide of these impurities. At 150° thionyl bromide undergoes a complex decomposition, yielding bromine and sulphur bromides. It is extremely hygroscopic and must be preserved in sealed tubes.

100. "Desulphurisation of the substituted thioureas." By Augustus E. Dixon, M.D.

Some years ago (*C. S. Trans.*, 1889, 618) the author pointed out that certain disubstituted paraffinoid thioureas are not desulphurised when boiled with an alkaline solution of a lead salt: having since obtained data concerning a considerable number of thioureas, the following conclusions are drawn as to their behaviour with the agent in question:—

1. The monosubstituted thioureas are all desulphurised.

2. The tri- (and probably also the tetra-) substituted thioureas are not.

3. Disubstituted thioureas containing one or more benzenoid groups are desulphurised, but not if such groups be absent.

In the case of thioureas containing the allyl group the results are less sharp than where alkyl residues are concerned: in the case of the former a trifling separation of lead sulphide is occasionally observed, but the amount produced varies from *nil* to enough to slightly darken the mixture; the effect in these cases is attributed to the difficulty encountered in obtaining the allyl derivatives in a pure condition.

The following compounds are described:—

sym.-*Diisobutylthiourea*, $CSN_2H_2(C_4H_9)_2$. — Colourless, rhombic plates, melting at 87—88°.

Di-(sec.)-butylthiourea, $CSN_2H_2(C_4H_9)_2$.—Small, colourless prisms, melting at 100—101° (uncorr.).

Methyl-(sec.)-butylthiourea, $CSN_2H_2(CH_3)(C_4H_9)$.—Flattened, rhombic crystals, melting at 79—80°.

Ethyl-(sec.)-butylthiourea, $CSN_2H_2(C_2H_5)C_4H_9)$. — Brilliant, flattened crystals, melting at 57—58°.

Phenyl-(sec.)-butylthiourea, $CSN_2H_2(C_6H_6)(C_4H_9)$.—Long, colourless needles; m. p. 100—101° (uncorr.).

Diisoamylthiourea, $CSN_2H_2(C_5H_{11})_2$. —Brilliant, small, white prisms; m. p. 72—73°.

Methylisoamylthiourea, $CSN_2H_2(CH_3)(C_5H_{11})$.—Beautiful, vitreous rhombs; m. p. 75—76°.

Ethylisoamylthiourea, $CSN_2H_2(C_2H_5)(C_5H_{11})$.—White, crystalline mass, melting at 45—46°.

Phenylisoamylthiourea, $CSN_2H_2(C_6H_5)(C_5H_{11})$.—Vitreous, rhombic lates, melting at 101—102° (uncorr.).

101. "Salts of active and inactive glyceric acid: the influence of metals on the specific rotatory power of active acids." By Percy F. Frankland, F.R.S., and J. R. Appleyard.

The authors have prepared and analysed a number of salts both of ordinary glyceric acid and of the dextrorotatory variety previously described by P. F. Frankland and Frew (*C.S. Trans.*, 1891, 96); the solubilities of many of them, and also the specific rotatory power in the case of the active salts, have been ascertained. The composition and solubilities of the corresponding salts are contrasted.

The specific rotatory powers of the several salts, determined in solutions containing about 10 per cent., are recorded in the following table, together with the molecular rotations of the salts and the calculated specific rotation of the glyceric acid corresponding to each salt:—

Salt.	Specific rotation, $[\alpha]_D$.	Molecular rotation, $\frac{M \times [\alpha]_D}{100} = [M]_D$.	Equivalent specific rotation of glyceric acid, $C_3H_6O_4$.
$Li(C_3H_5O_4)$	−20·66°	−23·14°	−21·83°
$Na(C_3H_5O_4)$	−18·13	−20·65	−19·48
$K(C_3H_5O_4)$..........	−16·46	−23·70	−22·36
$K(C_3H_5O_4)(C_3H_6O_4)$ ..	− 9·24	−23·10	−10·90
$NH_4(C_3H_5O_4)$	−18·05	−22·20	−20·94
$Ca(C_3H_5O_4)_2$.........	−13·34	−33·35	−15·73
$Sr(C_3H_5O_4)_2$.........	−11·91	−35·44	−16·72
$Ba(C_3H_5O_4)_2$	−10·01	−34·73	−16·38
$Mg(C_3H_5O_4)_2$........	−20·08	−46·99	−22·16
$Zn(C_3H_5O_4)_2$	−23·63	−65·05	−30·69
$Cd(C_3H_5O_4)_2$	−15·29	−49·23	−23·22

The authors point out the variations in the values for the specific rotation of the glyceric acid according to the different metals present in the salt. These values may be represented in round numbers, as unity in the case of the acid potassium salt, 1·5 in the case of salts of the alkaline earths, 2 in that of salts of the alkalis, magnesium and cadmium, and 3 in the case of the zinc salt. They compare these results with those which have been obtained by other observers in the case of other active acids and which have led to the generally accepted doctrine that the activity of an acid is influenced by the nature of the metal introduced in forming the salt. This doctrine is founded on the observations of Hoppe-Seyler on cholalic acid, of Oudemans on podocarpic and quinic acids, of Hartmann on camphoric acid and of Landolt on tartaric acid. The authors, however, call attention to the fundamental optical difference between most of these acids and glyceric acid: thus the rotation of the glycerates is both opposite in sign and much greater in degree than that of the acid, whilst, on the contrary, cholalic and camphoric acids have a greater rotation than may be deduced from their salts; and podocarpic acid again has practically the same rotation as may be calculated from its salts. Quinic acid, however, has a somewhat higher rotation than that deducible from its salts, and the same relationships between the rotations of the quinates subsist in miniature as are exhibited on an exaggerated scale by the glycerates: zinc quinate having a distinctly higher, and barium quinate a distinctly lower, rotation than that of the other quinates. In the case of tartaric acid, again, a much higher rotation may be deduced from its salts than is shown by the acid, but the salts of tartaric acid which have been examined for rotation are just those in which only comparatively insignificant differences are observable in the case of the glycerates, viz., the salts of the alkaline metals and magnesium; on the other hand, the excessively high rotation of tartar emetic shows that the antimonyl group, at any rate, has a most important influence in affecting the rotation of the acid. In the case of lactic acid, however, there is the fullest analogy to glyceric acid, the rotation of the lactates being both opposite in sign and much greater in degree than that of the acid, the ratio of the rotation in the zinc salt to that in the calcium salt (the only two lactates which have had their rotation determined) being also almost identical for lactic and glyceric acid, being 1·805 and 1·951 respectively.

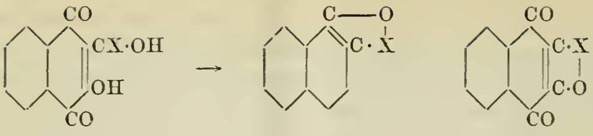
Before drawing any conclusions from these remarkable apparent relationships, the authors intend making a more detailed investigation of the rotations of these and other salts in solutions of different concentration. The results, however, as far as they go, appear to lend support and to extend the views on multiple rotation which have been expressed by Mulder (*Chem. Zeit.*, 1868, 58), Krecke (*J. pr. Chem.*, **5** (1872), 6), Landolt (*Ber.*, **6** (1873), 1073), and M. Thomsen (*Ber.*, 1880, 2168, 2264, 2269; 1881, 29, 134, 203, 807, 1647), but subsequently controverted by Landolt (*Ber.*, 1881, 296, 1048) and Oudemans (*Rec. Trav. Chim.*, 1885).

102. " Dibromo-β-lapachone." By Samuel C. Hooker and A. D. Gray.

Dibromo-β-lapachone was first obtained in very small quantity as a secondary product in the preparation of bromo-β-lapachone (*cf.* Trans., 1892, 640); although it was formed in the preparation of bromo-β-lapachone from lapachol, it was, nevertheless, impossible to produce it from bromine and pure bromo-β-lapachone. It is now shown that hydrogen bromide plays an important part in the conversion of the mono- into the di-bromo-derivative, an unstable additive compound of the former with bromine and hydrogen bromide being produced, which slowly passes into dibromo-β-lapachone. A number of derivatives prepared from dibromo-β-lapachone are described.

103. " The conversion of para- into ortho-quinone derivatives." By Samuel C. Hooker.

The author announces that he will subsequently adduce experimental evidence showing that, both in the lapachol and other groups, compounds derived from α-naphthaquinone, of the type represented by formula I, are far more readily converted by the action of acids into anhydrides derived from β-naphthaquinone (II) than, as might, perhaps, have been expected, into anhydrides of the α-quinone type (III).



I. II. III.

Thus, the benzal-dis-hydroxy-α-naphthaquinone of Zincke and Thelen (*Ber.*, **21**, 2203) is quantitatively converted into an anhydride derived from the β-quinone. A variety of similar compounds, derived from aldehydes other than benzaldehydes, have been prepared.

It will also be shown that, as in the case of the β-lapachones, the converse change of β-quinone anhydrides into α-quinone derivatives is easily effected by boiling with dilute solutions of caustic alkali. It is proposed to extend the experiments to hydroxyquinones generally.

104. "The nitro-derivatives of phenolphthalein." By John A. Hall, M.Sc.

The author calls attention to previous incidental references to nitro-derivatives of phenolphthalein by Baeyer (*Annalen*, **202**, 73), Frande (*ibid.*, p. 154) and O. Fischer (*ibid.*, **206**, 99).

As a pure dinitro-derivative was not obtained by nitrating a sulphuric acid solution, phenolphthalein was dissolved in 10 times its weight of acetic acid; a mixture of nitric acid and acetic acid was slowly added to the solution, keeping the temperature below 10°; 2 mols. of nitric acid were required by each mol. of phenolphthalein. After a time, a considerable quantity of yellow needles separated, which, after repeated recrystallisations, melted constantly at 196°. A nitrogen determination gave 6·91 per cent.; that calculated for dinitrophenolphthalein, $C_{10}H_{12}O_8N_2$, is 6·86 per cent.

Dinitrophenolphthalein forms yellow needles, fairly soluble in acetic acid and alcohol; it dissolves in alkalis with a yellow colour, but has practically no affinity for animal fibres. On reduction with sodium sulphide, it yields a fine blue solution, which, however, is very unstable. Frande states that, on reduction, his dinitrocresolphthalein yielded a blue solution, from which he isolated an amido-compound, but apparently did not analyse it. Some attempts were made to concondense phthalic anhydride and ortho- or para-nitrophenol, but without success.

Tetranitrophenolphthalein.—Phenolphthalein dissolved in five times its weight of sulphuric acid was nitrated with 2 mol. proportions of nitric acid at about 10°; the mixture was allowed to stand about two hours, and its temperature was then raised to from 20° to 30° and kept between these limits during the addition of another equal weight of nitric acid; as this second part of the nitration did not seem to proceed so rapidly as the first, the mixture was allowed to stand 12 hours, then poured into a large volume of water: the nitro-compound separated as a white precipitate, which was filtered and washed till free from sulphuric acid. The dried product proved to contain about 75 per cent. of a substance soluble in cold acetic acid to the extent of only about 1 per cent., which, by repeated recrystallisations from acetic acid or a mixture of phenol and alcohol, was obtained of a constant melting point (244—245°). A nitrogen determination gave 10·89 per cent.; that calculated for tetranitrophenolphthalein, $C_{20}H_{10}O_{12}N_4$, is 11·2.

Tetranitrophenolphthalein is difficultly soluble in most ordinary solvents; it forms pale yellow, indistinct crystals, readily soluble in alkalis; salts of the heavy metals, as barium, lead and silver, precipitate its neutral solution. The sodium salt is a yellow dye-stuff, sold under the name of aurotine.

On alkaline reduction it yields an unstable blue colour. It was also observed that when phenolphthaleinsulphonic acid (*Annalen*, **202**, 73) was treated with 2 mol. proportions of nitric acid in presence of sulphuric acid, it yielded a soluble nitrosulphonic acid, but when 4 mol. proportions of nitric acid were used and the temperature was allowed to rise to 30° C., the product was for the most part insoluble in water and consisted simply of impure tetranitrophenolphthalein.

The author thanks Mr. F. Moore, B.Sc., for the analytical figures which are quoted, and Dr. Dreyfus, Managing Director of the Clayton Aniline Company, where the experiments were made, for permission to publish the results.

105. "A method for the preparation of acetylene." By Morris W. Travers.

Maquenne has recently published (*Compt. rend.*, 1892) an account of a method of preparing acetylene by the interaction of water and barium carbide, the carbide being made by reducing barium carbonate with magnesium in the presence of carbon, a method which affords about half the calculated quantity of barium carbide. Wöhler obtained calcium carbide by heating calcium-zinc alloy with carbon in a graphite crucible.

Calcium carbide may be prepared in quantity by reducing calcium chloride with sodium in the presence of carbon. The operation is conducted as follows:—45 grams of sodium are placed at the bottom of a deep iron bottle, and an intimate mixture of powdered gas carbon and calcium chloride which has been well dried on a hot iron dish is then introduced; the top of the bottle, furnished with a long neck, having been screwed on, the bottle is heated to bright redness during half an hour; it is then removed from the fire, stoppered and cooled with water. When broken away from the bottle, the product is dark grey in colour and consists of sodium chloride, calcium carbide and the excess of carbon added to render the mass less compact; usually about 16 per cent. of carbide is formed, which is half the theoretical quantity. In practice, 1 gram of sodium thus converted into carbide is found to yield 240 c.c. of acetylene instead of 487 c.c., the calculated equivalent quantity.

ADDITIONS TO THE LIBRARY.

I. *Donations.*

Traité général d'analyse des beurres, par A. J. Zune. Deux volumes. Paris 1892. From the Author.

U.S. Geological Survey, Mineral Resources of the United States, by D. T. Day. Calendar years 1889 and 1890. Washington 1892. From the Director of the Survey.

Thesis on the action of Sulphuryl Chloride on Acetorthotoluide and Acetparatoluide, by W. P. Wynne. London 1892. (Pamphlet.) From the Author.

Recherches sur les rapports réciproques des poids atomiques, par J. S. Stas. Bruxelles 1860 (containing autograph of the Author). From W. Crookes, Esq.

Azione dell'etere cianacetico sulle basi organiche, del J. Guareschi. Torino 1892.

Sulle cianacetilamine e nuovi acidi ossamici, del J. Guareschi. Torino 1892. (Pamphlets.) From the Author.

II. *By Purchase.*

Chemical Lecture Experiments: Non-metallic Elements, by G. S. Newth. London 1892.

Methodes de travail pour les laboratoires de chimie organique, par Lassar Cohn: traduit de l'Allemand par E. Ackermann. Paris 1892.

Die Mikroorganismen der Gärungsindustrie, von A. Jörgensen. Dritte Auflage. Berlin 1892.

Leitfaden für Zuckerfabrikchemiker zur Untersuchung der in Zuckerfabrikation vorkommende Produkte und Hilfsstoffe, von E. Preuss.

Manipulations de Chimie, par E. Jungfleisch. Seconde édition. Paris 1892.

Jahrbuch der Chemie, herausgegeben von R. Meyer. I. Jahrgang, 1891. Frankfurt a.M. 1892.

Lehrbuch der Allgemeinen Chemie, von W. Ostwald. Band II. Chemische Energie: erste Hälfte. Leipzig 1892.

Chemische Präparatenkunde, von A. Bender and H. Erdmann. Band I. Anorganische Präparate, von A. Bender. Stuttgart 1893.

Die Bestimmung des Molekulargewichts in theoretischer und praktischer Beziehung, von R. Windisch. Berlin 1892.

Chemisch-technische Untersuchungsmethoden der Gross-Industrie, der Versuchsstationen und Handelslaboratorien, herausgegeben von F. Böckmann. Dritte Auflage: Zwei Bände. Berlin 1892.

Die Sulfosäuren der beiden Naphtylamine und der beiden Naphtole, zusammengestellt von E. Täuber. Berlin 1892.

Kurze Anleitung zur Auffindung der Gifte und stark wirkender Arzneistoffe, von W. Autenrieth. Freiburg i.B. 1892.

Leitfaden für den Unterricht in der Chemie, von R. Arendt. Vierte Auflage. Hamburg und Leipzig 1892.

Die Imido-äther und ihre Derivate, von A. Pinner. Berlin 1892.

Les Phosphates de chaux naturels, par P. Hubert. Paris 1892.

Specielle Methoden der Analyse—Anleitung zur Anwendung physikalischer Methoden in der Chemie—von G. Krüss. Hamburg und Leipzig 1892.

Stéréochemie, nouvelle édition de "Dix Années dans l'histoire d'une théorie," par J. H. Van't Hoff, rédigée par W. Meyerhoffer. Paris 1892.

Anleitung zur chemischen und mikroscopischen Untersuchung des Harnes, von A. Daiber. Leipzig und Wien 1892.

Die Technologie der Fette und Oele des Pflanzen- und Thierreichs, von C. Schaedler. Zweite Autlage, bearbeitet von P. Lohmann. Leipzig 1892.

Gesammelte Abhandlungen über Pflanzen-Physiologie, von J. Sachs. Band I. Leipzig 1892.

Textbook of Inorganic Chemistry, by Ira Remsen. London 1889.

KOPP MEMORIAL LECTURE.

An extra meeting of the Society will be held on February 20th, 1893, at 8 P.M., the anniversary of the death of Hermann Kopp, when a lecture will be delivered by Professor Thorpe, F.R.S.

CERTIFICATES OF CANDIDATES FOR ELECTION AT THE NEXT BALLOT.

N.B.—The names of those who sign from "General Knowledge" are printed in *italics*.

The following Candidates will be balloted for on February 16th, 1893:—

Boone, William Thomas,

6, Mount Pleasant Road, Tottenham.

Schoolmaster. Bachelor of Science, London University. Organising Secretary of North London Science and Art Classes, Tottenham, N. Lecturer in Theoretical and Teacher of Practical Chemistry in connection with these classes.

Robert R. Steele. G. Stillingfleet Johnson.
W. Popplewell Bloxam. *Vivian B. Lewes.*
Wm. J. McKerrow.

Brockbank, John Edwin,

The Croft, Kirksanton, *viâ* Carnforth.

Analytical Chemist. Chief Assistant to the County Analyst for Cumberland and Westmoreland.

Robert Hellon. William Henry Watson.
Archibald Kitchin. Geo. J. Snelus.
Thomas Purdie.

Brooke, Edward,

West Court Chalk, Gravesend, Kent.

Analytical Chemist. Two years in the Laboratory of the Pharmaceutical Society, and still engaged in Chemical Investigation. Joint Author of "Constituents of Pareira," and other papers (*Pharm. J.*, **22**, Series 3).

T. A. Ellwood. E. E. Burnett. E. P. Parry.
Edward D. Gravill. *H. Helbing.*

D'Albuquerque, John Pedrozo,

Barbados, W.I.

Professor of Chemistry. B.A. Cambridge. 1st Class in both of the Natural Sciences Tripos. Late Scholar of St. John's College. F.I.C. Government Professor of Chemistry, Barbados, W.I.

G. D. Liveing. H. J. H. Fenton. J. T. Hewitt.
S. Ruhemann. A. Hutchinson. William A. Tilden.
James Dewar. *Charles T. Heycock.*

Cowan, William James,

77, Trinity Road, Wood Green, London, N.

Fine Chemical Colour Manufacturer of Messrs. Holmes and Sons, Ouseburn, Newcastle-on-Tyne. Studied under Dr. Brass, of Coblenz, Dr. Seligmann, of Cologne, and Dr. Klingell, of Munich, also in the technical laboratory of the Baedische Aniline Company. Have been engaged in the manufacturing of high class chemical colours for many years; more recently have specially studied the preparation of the organic lakes, of which my firm now manufacture over 600 varieties.

A. P. Laurie. James Mactear. D. A. Sutherland.
Henry Seward. *John Pattinson.*

Davies, Daniel O. Sydney,

Rhydfallen, Stonebridge Park, Willesden, London, N.W.

Lecturer in Physics and Chemistry to the Staffordshire County Council, and Science Master, Alleyne's Grammar School, Uttoxeter. Graduate in Science (B.Sc.) University of London. Lecturer in Physics and Chemistry to the Staffordshire County Council, 1 year. Science Master Alleyne's Grammar School, Uttoxeter, 1 year. Science Master Shebben College, Devon, 1891, 1 year.

James J. Dobbie. George McGowan. Alexander Lauder.
Charles M. Adams. *Thomas Isherwood.*

Davey, George,

Las Trojas, Angangues, Michoacan, Mexico.

Chemist. 4 years Student in the Mining Schools and Chemical Laboratory of the Miners' Association of Cornwall and Devon Inorganic Chemistry and Practical Qualitative and Quantitative Chemical Analysis. First Advanced in Practical Inorganic Chemistry, 1880, Second Advanced in Theoretical Inorganic Chemistry, 1880, Science and Art Department, South Kensington. At present Metallurgist and Analyst to the Michoacan Railway and Mining Company, Las Trojas Smelting Works, Mexico.

Wm. Frank Grace. John J. Beringer. W. Terrill.
William T. Burgess. *George T. Holloway.*

Dreyfus, Charles, Ph.D., &c.,

Clayton Aniline Company, Limited, Clayton, Manchester.

Chemical Manufacturer. Director of the Clayton Aniline Company, Limited, and General Manager of the Works. Researches on Purification of Sewage, Improvements in preparation of Chemical Substances (patented). Discovery of New Aniline Dyes, &c.

J. Carter Bell.
R. Le Neve Foster.
Harry Grimshaw.
Wm. Beaumont Hart.
John A. Hall.
Howard C. Sacré.

Dufton, Felix, B.A., D.Sc.,

Spring Wood House, New Cross Street, Bradford.

Science Master. Late Assistant Demonstrator in Cambridge University Laboratory. Fellow of Trinity College, Cambridge.

G. D. Liveing.
Alexander Scott.
A. Hutchinson.
M. M. Pattison Muir.
S. Ruhemann.
H. J. H. Fenton.
Henry E. Armstrong.
William A. Tilden.

Elias, James,

Briton Ferry, Glamorganshire.

Surgeon. M.R.C.S. (Eng.). D.H.P. (Camb.). Studied Chemistry for 2 years at Aberystwith College; then proceeded to Owens College, and studied Chemistry under Sir H. Roscoe. Went through 5 years' Medical Curriculum at the latter College. Also studied at the State Medicine Laboratories, King's College, paying special attention to Chemistry in connection with Sanitary Science. At present engaged in Food Analyses and Bacteriological work.

H. E. Roscoe.
Walter Thorp.
R. Phillips Bedson.
Herbert Eccles.
Rhys P. Charles.

Elmore, Alexander Stanley,

Thwaite Gate, Leeds.

Electro-Metallurgist. Studied at the South London School of Chemistry for two years under Dr. J. Muter and Mr. L. de Koningh; then engaged for about 12 months on a series of experiments to determine the action of chlorine upon various metallic sulphides at different temperatures; then served two years in the electro-chemical laboratory of the Electrolytic Company, of London, principally upon experimental work; for the following three years engaged in the electrolytic refining of copper, and for the last four years engaged in research work in connection with the electro-deposition of copper, zinc, lead, and other metals. Also consulting Electro-Metallurgist.

Watson Smith.
Fredc. H. Bowman.
John Muter.
Leonard de Koningh.
Thomas Wardle.
John Knowles.
J. Carter Bell.
George H. Hurst.
Harry Grimshaw.

Evans, John Henry,

71, Lambton Road, Cottenham Park, Wimbledon.

Three years with W. H. Coates, M.B., F.G.S., &c., Analyst, 1887–90. Dispenser at the French Dispensary, with Herbert Painter; St. George's and St. James's Dispensary (5 years). In private practice now.

W. H. Coates. Alfred E. Pike. R. Grimwood.
Ernest P. Parry. *A. W. Oxford.* *A. W. Gerrard.*

Fuller, Frederick George,

52, Queen Victoria Street, E.C., and 19, Brunswick Square, W.C.

Metallurgical Chemist. Formerly pupil of the late Dr. Augustus Voelcker. Have practised as a Metallurgical Chemist, and am interested in chemical and other scientific research.

Herbert E. Kirby. Leonard T. Thorne. William Ramsay.
Edwin Richardson Blundstone. *T. E. Thorpe.*

Heath, Arthur John,

1, Grove Villas, Redland, Bristol.

Tutor. As student, have gone through the whole course at University College, Bristol (Theoretical and Practical), and taking the Honours Course in Chemistry, have passed the B.A. Examination of the Royal University, Ireland. Teacher of Chemistry in Upper Class Schools in Clifton. Given occasional Popular Lectures in Bristol.

Sydney Young. Arthur Richardson. Ernest H. Cook.
Thos. Coomber. J. William James.

Huntly, George Nevill,

56, Sheen Road, Richmond, Surrey.

Demonstrator in State Medicine Laboratories, King's College, London. Associate of the Royal College of Science, London. Have published papers in the Journal of the Society. (1.) With Professor Japp, "Action of Phenylhydrazine on an Unsaturated γ-Di-ketone." (2.) "Action of Phosphoryl Chloride upon Phosphorus Pentoxide."

T. E. Thorpe. William Tate. W. P. Wynne.
John M. Thomson. Herbert Jackson.

Lambert, Wesley,

55, Plumstead Common Road, Plumstead.

Analyst. Assistant Metallurgical Chemist, Royal Gun Factory, Woolwich.

G. Stillingfleet Johnson. A. K. Huntington.
R. Jas. Redding. *John M. Thomson.*
Herbert Jackson.

Luxmore, Charles M.,

529, Battersea Park Road.

B.Sc. (London). In 1884 passed the Major Examination of the Pharmaceutical Society, and was awarded the Society's Silver Medal. Now working in the Research Laboratory of the Pharmaceutical Society.

Wyndham R. Dunstan. M. Carteighe.
John M. H. Munro. Chas. Umney.
W. H. Symons.

Marsden, Fred,

Bangor, N. Wales.

Assistant Lecturer and Demonstrator in Chemistry, University College, Bangor. B.Sc. (Honours in Chemistry), Victoria University. Ph.D., Heidelberg University. Dissertation, "Zur Kenntniss des Acetylens," "Ueber die Reduction des Benzolazoorthokresetols."

James J. Dobbie. Alexander Lauder.
G. H. Bailey. W. H. Perkin, Jun.
Arthur Harden.

Mole, Herbert Bloome,

Hillside, Shepton Mallet.

For three years a Student in Chemistry at the Central Institution, under Dr. Armstrong. For two years Assistant Chemist at Messrs. Garton, Hill, and Co.'s Sugar Factory.

Henry E. Armstrong. John Heron.
E. R. Moritz. Chas. Geo. Matthews.
Jas. O'Sullivan.

Owen, Robert Henry,

Plas-y-Coed, Troedyrhiw, near Merthyr Tydfil.

Analytical Chemist. Chief Analytical Chemist (several Assistants under him) at the Cyfarthfa Steel Works of Messrs. Crawshay, Brothers, Ld.

Henry Heywood. G. T. Evans.
John Wm. Stanley. *Leonard Archbutt.*
Geo. J. Snelus. *R. W. Atkinson.*

Platt, Charles, A.C.,

Buffalo, N.Y., U.S.A.

Analytical and Consulting Chemist, the Vandenburgh Laboratory of Chemical Industry. Graduate in Chemistry, Lehigh University; Assistant Chemist Cambria Iron Works; Chief Chemist with Thos. A. Edison; at present Secretary and Treasurer for the Vandenbergh Laboratory of Chemical Industry of Buffalo, N.Y., U.S.A. Assoc. Editor, *Engineering Magazine*, New York City, Author of Articles in *Science*, N.Y., *The Engineering and Mining Journal*, N.Y., *The Annals of Hygiene*, Philadelphia.

Lionel R. Lenox.	W. H. Chandler.
Ernest A. Congdon.	*Edgar F. Smith.*
Theodore G. Wormley.	*A. B. Griffiths.*

Southwell, Charles Henry,

Boston.

Analytical Chemist. Some time Laboratory Manager for Messrs. Wyley and Co., Coventry. Pharmaceutical Chemist. F.R.M.S. Public Analyst for the Administrative County of the Parts of Holland, Lincolnshire.

Arthur W. Clayden.	E. Wightman Bell.
W. F. Wyley.	*Hy. Williams Jones.*

Jas. Baynes.

Thackrah, James Robert, M.A., Ph.D.,

Technical Schools, Plymouth.

Demonstrator and Assistant Lecturer in Chemistry at the Plymouth Science, Art, and Technical Schools. Worked for three years in the University Laboratory at Oxford. Worked for four years in the University Laboratory at Leipzig. B.A., Oxford, 1886. Ph.D., Leipzig, 1891. Subject of Thesis for Leipzig Degree, "A Condensation Product of Crotonic Acid, and its Change into β-Oxybutyric Acid."

R. Elliot Steel.	W. W. Fisher.	John Watts.
Arthur Colefax.	Wm. Odling.	*V. H. Veley.*

Towers, John William,

Brantwood, Allerton, near Liverpool.

Manufacturing Chemist and Laboratory Furnisher. Second Class Honours, and distinguished in Chemistry, Cambridge Local Examination, 1870. Studied under Sir H. E. Roscoe, Owens College, 1872. Five years with Messrs. J. Hutchinson and Co., Widnes, as Chemist. Five years with the Atlas Chemical Co., Widnes, as Chemist. Ten years in business manufacturing pure acids and chemicals, and as Laboratory Furnisher at Widnes.

Edward Davies.	John Hargreaves.
R. Dormer.	John H. J. Dagger.
Edward Rhodes.	Alfred Smetham.
F. H. Tate.	James Hargreaves.

Tyrer, Charles Thomas,

Stirling Chemical Works, Stratford, E.

Manufacturing Chemist; at present in charge of Tyrer and Co.'s

Laboratories. Student in the Finsbury Technical College under Professor Meldola, F.R.S., and Messrs. Streatfeild and Evans, and now Works Chemist and Manager.

Rudolph Messel. David Howard.
C. R. Alder Wright. Willm. Thorp.
Arthur R. Ling. Chas. Umney.
James Dewar.

Umney, John Charles,

50, Southwark Street, London, S.E.

Manufacturing Chemist. Studied for two years in the School of the Pharmaceutical Society. Silver and Bronze Medallist in Practical Chemistry. Passed the Major Examination of the Society. Worked subsequently for one session in the Research Laboratory of the Pharmaceutical Society. Joint author, with Professor Dunstan, of "The Alkaloids of true *Aconitum napellus*" (*J. Chem. Soc.*, 1892), also author of several papers published in the *Pharm. J.*, 1888—1892.

Wyndham R. Dunstan. M. Carteighe.
John Attfield. Thomas Tyrer.
William A. Tilden. *David Howard.*

Wheeler, William Ernest,

Cumberland House, Meynell Road, S. Hackney, N.E.

Assistant Analytical Chemist at Messrs. Lewis Berger and Co.'s Colour Factory, Homerton. Studied Chemistry at King's College Evening Classes under Mr. Geo. Stillingfleet Johnson, 1888—1889. Four years engaged in the Chemical Laboratory at Messrs. Berger's Works, Homerton. Is likewise partly qualified as an Electrical Engineer.

Willm. Thorp. R. Tervet.
John Spiller. G. Stillingfleet Johnson.
D. A. Sutherland. *W. Sharman.*

Wills, Herbert, LL.D.,

Fern Bank, Halliwell, near Bolton.

Schoolmaster and Author. Student, First Class Certificates, Science and Art Department, London. Teacher of Chemistry; Author.

William Brandwood Mason. Edw. W. Napper.
Thomas Cockerill. *William Ward.*
Wm. Thos. Gent.

Wood, John Cundell,

3, Belford Terrace, Sunderland.

Medical Officer of Health. Physician to Fever Hospital, and Public Analyst for Borough of Sunderland. Lic. Col. Physicians;

Lic. Col. Surgeons, and holder of Diploma of Public Health, Edinburgh, &c.

John Hunter.
Charles Ranken.
W. Dixon.
John C. Hewlett.
John Pattinson.
Hugh Erat Harrison.
Charles J. Wilson.
M. F. Purcell.
Carl von Buch.

The following Candidates are recommended by the Council for ballot under Bye-law I (para. 3):—

Dunnington, Francis P.,

Charlottesville, Va., U.S.N.A.

Professor of Analytical and Agricultural Chemistry, University of Virginia. For the last 20 years a Professor of Chemistry in the University of Virginia. Author of published papers "On the Chemical Composition of the Ashes of certain widely-distributed Weeds;" "On Analyses of Microlite, Monazite, Columbite, and Orthite;" "On a Filtration Balance;" "On the Formation of Manganese Deposits;" "On the Estimation of Titanium by means of Hydrogen Dioxide;" "On the Distribution of Titanium in Rocks and Soils," &c.; also of several papers on the results of laboratory work by students under under his direction.

J. W. Mallet.
F. P. Venable.
W. G. Brown.

Haller, Albin,

14, Rue de Metz, à Nancy, France.

Directeur et Professeur de l'Institut chimique de la Faculté des Sciences de Nancy. Travaux et publications: "Recherches sur les camphols et les camphres, camphre cyané, cyanoalcoylé, acide hydroxy-camphocarbonique, &c."; "Sur une nouvelle classe de composés à reactions acide, Ethers cyanomaléinique, acetylcyanoacétique, benzoylcyanacétique, propionylcyanacétique, &c."; "Recherches sur les urées, sur le fonction de l'acide camphorique"; "Synthèse de l'acide citrique," en collaboration avec M. Held; "Recherches sur les acides cyanosuccinique, cyanotricarballylique," en collaboration avec M. Barthe," &c., &c. Corréspondant de l'Institut de France et de l'Académie de Médecine.

Henry E. Armstrong.
W. Ramsay.
J. H. Gladstone.

Martin, William J., Junr., M.D.,

Charlottesville, Va., U.S.N.A.

Instructor in Chemistry, University of Virginia. Now Assistant to the Senior Professor of Chemistry in the University of Virginia.

Formerly Acting Professor of Chemistry in Davidson College, North Carolina. A competent Teacher of Theoretical and Practical Chemistry.

J. W. Mallet. W. G. Brown. *F. P. Venable.*

Wait, Chas. E.,

Knoxville, Tenn., U.S.N.A.

Professor of Chemistry, University of Tennessee. Formerly, and for several years, Professor of Chemistry in and Director of the State School of Mines at Rolla, Missouri. Author of published papers on "The Antimony Deposits of Arkansas," on "A Sample of Melanterite," on "The Analysis of Bindheimite," on "A New Machine for Making Assay Cupels," on "The Use of Gasolene Vapour as Fuel in Chemical Laboratories," on "The Condition of Silver in a Sample of Bismuth Litharge," &c.

J. W. Mallet. F. P. Venable. W. G. Brown.

Walke, Willoughby,

Fort Monroe, Va., U.S.N.A.

First Lieutenant, 5th U.S. Artillery. Instructor in charge of Department of Chemistry and Explosives, U.S. Artillery School. Has for several years taught the subjects in his charge to the Artillery Officers of the U.S. Army, who are sent in classes to the Artillery School at Fort Monroe. Author of manuals and pamphlets on "Gunpowder," on "High Explosives," on "Chemical Analysis," used as text-books in the School; also of a paper on "The Determination of the Strength of Various High Explosives."

J. W. Mallet. *F. P. Venable.* *W. G. Brown.*

White, Henry C.,

Athens, Georgia, U.S.N.A.

Professor of Chemistry, University of Georgia. For the last twenty years Professor of Chemistry in the University of Georgia, and for ten years also Official Chemist of the State of Georgia: now also Vice-Director of the State Agricultural Experiment Station. Author of published papers on "The Chemistry of the Cotton Plant," on "The Marls of Southern Georgia," on "A Modification of Ruffle's Method for the Determination of Nitrogen," on "Methods of Determining Phosphoric Acid in Commercial Fertilisers," on "Ash Analyses of Native Woods," &c.

J. W. Mallet. *F. P. Venable.* *W. G. Brown.*

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Issued 9/2/1893.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

No. 119. Session 1892–93.

February 2nd, 1893. Dr. W. H. Perkin, F.R.S., Vice-President, in the Chair.

Mr. Walter H. Ince was formally admitted a Fellow of the Society.

Ordinary certificates were read for the first time in favour of Messrs. John Frederick Briggs, c/o Messrs. Parry & Co., Madras; Julian L. Baker, Stamford, Hendham Road, Upper Tooting, S.W.; William A. Bone, Schlossberg 3, Heidelberg; H. W. Dickinson, Kent Place, Ulverston, Lancashire; John Addyman Gardner, 5, Bath Place, Oxford; John Alan Murray, 60, Marine Terrace, Aberystwyth; Alan E. Munby, 44, Holly Avenue, Newcastle-on-Tyne; J. Frank McGregory, M.A., Hamilton, N.Y., U.S.A.; James Henry Robbins, 4, Roderick Road, Haverstock Hill, N.W.; William Rintoul, 48, Carnarvon Street, Glasgow; George Rudd Thompson, 5, Clytha Square, Newport, Mon.

Of the following papers, those marked * were read:—

*106. "The connection between the atomic weight of the contained metals and the magnitude of the angles of crystals of isomorphous series" By Alfred E. Tutton, Assoc. R.C.S.

The author has subjected the crystals of 22 salts of the series of double sulphates $R_2M(SO_4)_2 \cdot 6H_2O$ containing as the alkali metal R potassium, rubidium and cæsium respectively, and as the second (dyad) metal M magnesium, zinc, iron, maganese, nickel, cobalt, copper and cadmium respectively, to a detailed goniometrical investigation, with the purpose of ascertaining the nature of the connection specified in the title. The measurements have been made in great detail, at least 10 crystals of each salt, of the highest procurable degree of purity and perfection, selected from several different crops, having been completely measured: an average of over 400 measurements have thus been made in the case of each salt, 40 separate values of each of the principal angles being frequently obtained; this being considered necessary in view of the smallness of the differences under investigation, in order that on taking the mean of all the values of each angle the errors due to slight disturbances during deposition, and also the instrumental errors, might be eliminated. The purity of each salt was established by direct analysis. The 22 salts are fully described in the paper, and complete tables of their angles given. After each set of three salts containing the same second metal and potassium, rubidium and cæsium, respectively, as the alkali metal have been thus described, their angles are compared and the morphological relations are discussed.

The results of the investigation are embodied in the following summary:—

1. The salts containing cæsium as the alkali metal are the most readily obtained in the form of crystals; those containing potassium the least; the salts containing rubidium occupying an intermediate position in this respect.

2. Though bounded by the same common planes, the crystals of the potassium, rubidium and cæsium salts of the series exhibit specific characteristic habits, the characteristic habit of the crystals of the potassium salts being widely different from that exhibited by the crystals of the cæsium salts, and the habit usually assumed by the crystals of the rubidium salts being of an intermediate character. The relations between the characteristic habits of the potassium, rubidium and cæsium salts respectively are thus found to be in direct correlation with the atomic weights of the alkali metals.

3. The axial angle β increases with the increase in the atomic weight of the alkali metal, its magnitude in any rubidium salt of the series being approximately midway between that in the potassium and that in the cæsium salt containing the same second metal; in other words, the differences between the magnitudes of the axial angle in crystals of this series containing potassium, rubidium and cæsium respectively as the alkali metal are in direct simple proportion to the differences between the atomic weights of these metals.

The changes in the magnitude of the axial angle on passing from a potassium to a rubidium salt, and from a rubidium to a cæsium salt, are very considerable, usually exceeding a whole degree in each case; they are therefore far outside the limits of possible experimental or formational error.

4. The magnitudes of all the angles between the faces of the crystals of the salts of this series containing rubidium as the alkali metal lie between the magnitudes of the corresponding angles upon the crystals of the salts containing potassium and cæsium respectively.

The differences between the magnitudes of the angles, other than the axial angle, in crystals of this series containing potassium, rubidium and cæsium respectively as the alkali metal are not generally in direct simple proportion to the differences between the atomic weights of these metals. The maximum deviation from simple proportionality occurs in the prism zone, in which the ratio of the differences varies, according to the nature of the second metal present, from 1 : 2 to 1 : 3

The fact that the differences between the magnitudes of many of the angles of the cæsium and rubidium salts are so much larger than those between the rubidium and potassium salts would appear to indicate that as the atomic weight increases it exercises an influence on these angles in excess of the mere numerical proportion to its increase. This influence is most apparent in the case of the angles of the prism zone, and becomes less and less evident in the zones approaching more and more nearly to the plane of symmetry, until at length, in the case of the axial angle lying in the plane of symmetry, all evidence of it disappears, and the differences are then directly proportional to the numerical differences in atomic weight.

5. The alkali metals exert a preponderating influence in determining the geometrical form of the crystals, the magnitudes of the angles being altered on displacing one alkali metal R by the next higher or lower to an extent attaining a maximum in certain angles of more than a whole degree, while the displacement of the second (dyad) metal M by any other of the same group is unattended by any material change in the angular magnitudes.

6. The importance of the axial ratios as indicative of the change of geometrical form on displacing one alkali metal in any salt of the series by another is greatly diminished by the fact that simultaneous changes, more or less neutralising each other, occur in the angles which determine them, thus causing the differences to be small. It is generally observed, however, that in any set of three salts containing the same second metal the ratios in the case of the rubidium salt lie between those of the potassium and cæsium salts, and somewhat nearer to those of the potassium salt. The changes in the angles themselves afford the only complete information concerning the change in geometrical form.

The optical properties of the crystals of the salts now considered will be described and discussed in a subsequent communication.

DISCUSSION.

Mr. MIERS remarked that Mr. Tutton appeared to attribute the intermediate position occupied by the rubidium sulphates to the fact that the atomic weight of rubidium is the arithmetic mean of those of potassium and cæsium; if this were the simple cause, we should expect similar relations to obtain in the lithium, sodium and potassium, or the calcium, strontium and barium series, or in the case of an homologous series of hydrocarbon radicles. The strontium salts, however, are not intermediate in form between those of barium and calcium in the case of the bromates, the sulphates or the carbonates, and even in the potassium-rubidium-cæsium series the platinonitrites and the platiniodonitrites prepared by Nilson afford results showing that the rubidium salt does not necessarily occupy an intermediate position. Hence it is impossible at present to draw simple general conclusions from the results afforded by these or other isomorphous series, as the relations obtaining in one series do not generally prevail in others. Mr. Miers expressed the hope that Mr. Tutton would extend his observations to the isomorphous selenates.

*107. "The preparation of phosphoric oxide free from the lower oxide." By W. A. Shenstone and C. R. Beck.

A description is given of a method of preparing phosphoric oxide free from the lower oxides by distilling it over platinum sponge in the presence of excess of oxygen. The authors refer to a similar process lately described by Professor Threlfall (*Phil. Mag.*, January, 1893), and call attention to certain points in this process which in their experience considerably improve its efficiency and value.

DISCUSSION.

Professor THORPE, referring to the strictures passed on the commercial phosphoric oxide by Mr. Shenstone, said that in his experience it was by no means unsatisfactory in quality. Mr. Tutton and he had failed in extracting more than a minute proportion of phosphorous oxide from it.

Mr. H. B. BAKER agreed with Professor Thorpe; he had been in the habit of testing for the tetroxide by means of carbon tetrachloride, which dissolves it but not phosphoric oxide.

Mr. SHENSTONE, in reply, said that he had not intended to imply more than that the commercial product was impure; the percentage of impurity was probably small.

*108. "Contributions to our knowledge of the aconite alkaloids. Part IV. On isaconitine (napelline)." By Wyndham R. Dunstan and E. F. Harrison:

The authors have investigated the nature and properties of the alkaloid found together with aconitine in the roots of *Aconitum napellus* (see Part II), to which it was proposed to assign the old, disused name of napelline; this alkaloid always occurs in the roots to as large an extent as aconitine and in some cases to a larger extent. The preparation of the pure substance is fully described in the paper. Its separation from aconitine is based on the superior solubility of the latter in ether, while its superior solubility in chloroform affords a means of separating it in greater part from the other associated alkaloids; it is finally purified by recrystallising its hydrochloride. It is found to be *isomeric* with aconitine, and the name *isaconitine* is therefore now adopted instead of napelline, to which objections were raised on a former occasion.

Isaconitine has hitherto always been obtained in a colourless, friable, varnish-like form, resisting all attempts to crystallise it; it is readily dissolved by alcohol and chloroform, less readily by ether, and it is only slightly soluble in water, though more so than aconitine. The alcoholic solution is feebly dextro-rotatory.

The *hydrochloride*, $C_{33}H_{45}NO_{12}{\cdot}HCl$, crystallises from water in rosettes soluble in alcohol, containing 1 mol. prop. of water. The aqueous solution is intensely bitter, and is lævorotatory to almost the same extent as the aconitine salt, $[\alpha]_D = -28{\cdot}74°$.

The corresponding *hydrobromide* and *hydriodide* form similar crystals, but are anhydrous; the latter salt is lævorotatory, $[\alpha]_D = -26{\cdot}94°$. All these compounds somewhat resemble the corresponding aconitine salts in their physical properties.

Isaconitine exhibits a remarkable behaviour with auric chloride which sharply distinguishes it from aconitine, and, indeed from most other alkaloids. Hitherto no definite *aurichloride* has been obtained, but it is found that when solutions of the hydrochloride and of auric chloride are mixed, a yellow, amorphous precipitate is produced as in the case of aconitine; on recrystallising this from alcohol, nearly colourless crystals are obtained of an *aurochlorisaconitine*, of the formula $C_{33}H_{44}(AuCl_2)NO_{12}$. This is apparently a derivative of the alkaloid in which one atom of hydrogen is displaced by the group $AuCl_2$. The first known alkaloidal derivative of this type, namely, aurochlorcaffeine, was described a short time ago by Dunstan and Shepheard (*cf.* Trans., Feb., 1893). The production of such a compound from napelline was altogether unexpected. Aurochlorisaconitine differs, however, from aurochlorcaffeine in not being reconverted into the aurochloride by the action of hydrogen chloride.

When isaconitine is heated either with water in closed tubes or under ordinary pressure with mineral acids, it is gradually hydrolysed. The hydrolysis is more rapidly effected by aqueous solutions of soda or potash, which act even in the cold. It yields the same products as aconitine and the same proportions, viz., aconine and benzoic acid, $C_{33}H_{45}NO_{12} + H_2O = C_{26}H_{41}NO_{11} + C_7H_6O_2$.

The physiological action of isaconitine has been compared with that of aconitine by Professor Cash, who finds that the action of the two alkaloids is entirely distinct. A solution of a pure isaconitine salt does not produce the tingling sensation on the tongue which is so characteristic of aconitine; and while aconitine is a most violent poison, even in excessively minute doses, relatively considerable quantities of isaconitine must be administered to small animals in order to produce a toxic effect, which effect is the result of a physiological action in the main distinct from that of aconitine. It seems doubtful whether isaconitine would prove toxic to man, except when given in very large doses.

It may be added that the new alkaloid now described under the name of isaconitine is entirely different from the mixtures of amorphous alkaloids called napelline by the earlier workers. It also differs in composition and properties from the picraconitine of Wright and the amorphous bases since obtained from the roots of *Aconitum napellus* by other investigators. Having regard to the manner in which these amorphous bases were prepared, and to the extreme difficulty which is experienced in preparing pure isaconitine, it may be safely concluded that they were not single substances.

*109. "Contributions to our knowledge of the aconite alkaloids. Part V. The composition of some commercial specimens of aconitine." By Wyndham R. Dunstan and Francis H. Carr.

The authors have examined a number of English and foreign specimens of aconitine. For several of these they are indebted to Dr. J. W. L. Thudichum, who collected them some years ago; others have been purchased during the last two years. Dr. Thudichum had found that the various specimens differed enormously in their toxic power, many being nearly inert, while a few were highly poisonous.

The process used in examining these "aconitines" was essentially that described in the preceding communication by means of which aconitine, isaconitine, homisaconitine (homonapelline) and aconine could be isolated, and the quantity of each approximately determined. The method of estimating aconitine first proposed by Wright, and recently advocated in a slightly modified form by Allen, in which the benzoic acid produced on hydrolysis of the mixture of alkaloids is reckoned as derived from aconitine, is valueless, since isaconitine furnishes benzoic acid in the same proportion as aconitine when hydrolysed. Sixteen specimens of "aconitine from *A. napellus*" and its salts were examined. Most of the samples were amorphous; these were invariably found to contain but a very small proportion of aconitine, in some cases none, but were chiefly composed of the amorphous alkaloids aconine, isaconitine and homisaconitine, all of which appear to be very slightly, if at all, toxic. It would seem that, as a rule, "amorphous aconitine" represents the total alkaloids of the root. Of the crystalline specimens of alkaloid only two were pure, most of them being contaminated with more or less amorphous alkaloid. The specimens of aconitine salts examined were found, in nearly every case, to be chiefly isaconitine salts containing only small quantities of aconitine compounds. Hence it is not surprising that great differences have been observed in the mode of action and toxic power of commercial "aconitine." It is most important that in future nothing but pure crystalline aconitine possessing the characters fully described in Part I of the enquiry should be used in medicine, and it is satisfactory that a pure alkaloid can now be obtained in commerce.

DISCUSSION.

Mr. HOWARD characterised the discovery of the extraordinary difference between aconitine and the isaconitine now described as a striking example of the value of high "theoretical" chemistry; the discovery of the explanation of the difference would be of the deepest interest.

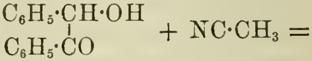
Dr. STEVENSON, after alluding to the impure nature of German commercial aconitine, dwelt on the importance of using crystallised material, which gave fairly constant results; such was the virulence of the alkaloid that 2/1,000ths of a grain never failed to kill a large mouse, and 3 milligrams usually proved fatal to an adult man.

Dr. BRUNTON spoke of the fear of prescribing "aconitine," which existed owing to its irregular character; in the course of experiments made 22 years ago, he had himself obtained most conflicting results, having, doubtless, used different "aconitines." He then remarked on the scientific interest attaching to the determination of the nature of the alkaloidal constituents of the various species of aconite, and the light which might thereby be shed on the origin of the different alkaloids: *A. heterophyllum*, unlike most species, contained no poisonous principle, and it would be specially interesting to examine this.

Professor DUNSTAN, in reply, said that German aconitines were not all amorphous and valueless; moreover it was a mistake to suppose that a sample was pure because it was crystalline. *A. heterophyllum*, to which Dr. Brunton had alluded, had a very bitter taste; as this was characteristic of isaconitine, perhaps this alkaloid was present.

110. "Synthesis of oxazoles from benzoin and nitriles." By Francis R. Japp, F.R.S., and T. S. Murray, D.Sc.

The authors find that nitriles and benzoin interact when a mixture of the two compounds is dissolved in concentrated sulphuric acid, water being eliminated, an oxazole being formed in which the hydrocarbon radicle attached to the cyanogen of the nitrile occupies the *meso*-position, *e.g.*, in the case of acetonitrile, which yields $\alpha\beta$-diphenyl-μ-methyloxazole (m. p. 28°),



$$\begin{array}{l}C_6H_5\cdot CH\cdot OH\\ C_6H_5\cdot \overset{|}{C}O\end{array} + NC\cdot CH_3 = \begin{array}{l}C_6H_5\cdot C\cdot O\\ \quad\ \ \| \\ C_6H_5\cdot C\cdot N\end{array}\!\!>C\cdot CH_3 + H_2O.$$

In addition to the foregoing, they have prepared *$\alpha\beta$-diphenyloxazole*, $C_{15}H_{11}NO$ (m. p. 44°), from benzoin and hydrogen cyanide; *$\alpha\beta$-diphenyl-μ-ethyloxazole*, $C_{17}H_{15}NO$ (m. p. 32°), from benzoin and propionitrile; and *triphenyloxazole*, $C_{21}H_{15}NO$ (m. p. 115°), from benzoin and benzonitrile. Triphenyloxazole is identical with Laurent's *benzilam* and Zinin's *azobenzil*.

By heating $\alpha\beta$-diphenyl-μ-methyloxazole with ammonia, it is converted into the corresponding imidazole, identical with Japp and Wynne's methyldiphenylglyoxaline, the oxygen atom in the ring being displaced by NH.

111. "The action of nitrosyl chloride and of nitric peroxide on some members of the olefine series." By William A. Tilden and J. J. Sudborough.

The authors have examined the action of nitrosyl chloride on the first five members of the olefine series with the following results:—Ethylene forms only the dichloride; propylene and butylene a mixture of dichloride and nitrosochloride, while trimethylene (amylene) is almost entirely converted into a nitrosochloride. Phenylethylene (cinnamene) behaves like trimethylethylene. Further, it is now found that propylene affords a compound similar to that prepared by Guthrie many years ago from nitric peroxide and amylene. The study of these compounds has been undertaken with the view of elucidating the constitution of the nitrosochlorides formed by the terpenes.

112. "Piperazine." By W. Majert and A. Schmidt.

Erroneous statements have appeared in several modern text books regarding the physical and chemical characters of piperazine, $C_4H_{10}N_2$, which have been confused with those ascribed by A. W. von Hofmann and by Ladenburg to the impure substances of like composition discovered by them, and termed respectively diethylenediamine and ethylenimine or diethylenediimine; our attention has been directed to the fact that this misunderstanding has partly arisen from a misconstruction of our views (*Ber.*, 1890, 3719) as to the identity of these substances: we, therefore, desire to correct this impression.

Piperazine, which was not known in its pure crystalline condition until prepared by us in August, 1890, by treatment of dinitrosodiphenylpiperazine with alkali, is a crystalline substance melting at 104—107° in capillary tubes, although when the melting point is determined on large quantities it is found to be 112°, the differences being due to the hygroscopic nature of the base; it boils at 140—145°. It is very readily soluble in water and alcohol, the aqueous solution having a distinctly alkaline action. It is very hygroscopic and readily absorbs carbon dioxide, being thereby converted into the carbonate melting at 162—165°.

Piperazine is especially characterised by the formation of an insoluble pomegranate-red double salt with bismuth iodide and by a dibenzoyl compound melting at 191°.

The basic substance diethylenediamine prepared by Hofmann by the interaction of ammonia and ethylene bromide consisted of a liquid mixture of bases boiling approximately at 170°. That this mixture contained a small quantity of a base identical with piperazine is undoubted, but it was only after piperazine had been prepared from dinitrosodiphenylpiperazine that Hofmann succeeded in identifying it and isolating the pure crystalline product from the mixture, which, besides higher ethylene bases, contained also a number of vinyl compounds.

Owing to the difficulty of purifying small quantities of the base, Ladenburg's experiments with diethylenediimine, obtained by the decomposition by heat of ethylenediamine hydrochloride, were unsuccessful: the product described by Ladenburg as the base was undoubtedly impure piperazine carbonate, as proved by its melting point, 159—163°.

In conclusion, it may be interesting to mention that we have succeeded in preparing the following series of hydrates of piperazine, that most readily formed being a hexhydrate which crystallises from dilute aqueous solutions:—

$C_4H_{10}N_2\cdot H_2O$, m. p. 75°,
,, $2H_2O$, ,, 56°,
,, $3H_2O$, ,, 39—40°,
,, $4H_2O$, ,, 42—43°,
,, $5H_2O$, ,, 45°,
,, $6H_2O$, ,, 48°.

KOPP MEMORIAL LECTURE.

An extra meeting of the Society will be held on February 20th, 1893, at 8 P.M., the anniversary of the death of Hermann Kopp, when a lecture will be delivered by Professor Thorpe, F.R.S.

At the next meeting, on February 16th, there will be a ballot for the election of Fellows; and the following papers will be read:—

"Platinous chloride." By W. A. Shenstone.

"The melting points of compounds of similar constitution." By F. S. Kipping.

"The electrolysis of sodic ethylic camphorate." By James Walker.

"Note on optical properties as indicative of structure." By H. E. Armstrong.

"A new base from *Corydalis cava.*" By J. J. Dobbie and A. Lauder.

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PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

No. 120. Session 1892–93.

February 16th, 1893. Professor A. Crum Brown, F.R.S., in the Chair.

It was announced that the following changes in the Council were proposed by the Council:—

As President: Professor H. E. Armstrong, *vice* Professor Crum Brown.

As Vice-Presidents: Dr. E. Atkinson and Mr. C. O'Sullivan, *vice* Professor Hartley and Mr. Warington.

As Secretary: Professor Dunstan, *vice* Professor Armstrong.

As ordinary members of the Council: Messrs. C. F. Cross, Bernard Dyer, D.Sc., Lazarus Fletcher, M.A., and W. A. Shenstone, *vice* Mr. H. Bassett, Professor Ferguson, Mr. J. Heron and Mr. S. U. Pickering.

Messrs. Holland Crompton, T. S. Dymond and Dr. T. A. Lawson were appointed to audit the Society's accounts.

Ordinary certificates were read for the first time in favour of Messrs. Lawrence Augustus Baine, Dipton, Lintz Green, Newcastle-on-Tyne; George Clayton, School of Pharmacy, 100, Burlington Street, Manchester; Robert George Grimwood, 41, Lady Margaret Road, St. John's College Park, N.W.; Alfred Rowland Gower, 39, Stafford Street, Barrow-in-Furness; Hooper Albert Dickinson Jowett, 3, Fern Bank, Lancaster; Herbert Lloyd, Philadelphia, U.S.A.; Edmund George Lamb, 29, Great Cumberland Place, W.; James Mason, Cambois, Blyth, Northumberland; Henry John Monson, 15, Palace Street, Buckingham Gate, London, S.W.; William Henry Oates, Broomhall Park, Sheffield; S. Parrish, 15, Fenton

Street, Woodhouse Lane, Leeds; Frank P. Vandenbeigh, B.S., M.D., Buffalo, New York; A. F. Watson, 11, York Place, Edinburgh.

The following were duly elected Fellows of the Society:—John Pedrozo D'Albuquerque; William Thomas Boone; John Edwin Brockbank; Edward Brooke; George Davey; Daniel O. Sydney Davies; Charles Dreyfus, Ph.D.; Samuel Felix Dufton, B.A., D.Sc.; Francis P. Dunnington; Alexander Stanley Elmore; Frederick George Fuller; Albin Haller; George Nevill Huntly; Arthur John Heath; Wesley Lambert; Charles M. Luxmore; Fred. Marsden; Herbert Bloome Mole; William J. Martin, Jun., M.D.; Robert Henry Owen; Charles Platt, A.C.; James Robert Thackrah, M.A., Ph.D.; Charles Thomas Tyrer; John William Towers; John Charles Umney; Henry C. White; Willoughby Walke; Charles E. Waite; William Ernest Wheeler.

Of the following papers those marked* were read:—

*113. "Note on the preparation of platinous chloride, and on the interaction of chlorine and mercury." By W. A. Shenstone and C. R. Beck.

In a paper read before the Society last year (*C. S. Trans.*, 1892, 445) we gave the results of the analysis of the gas evolved on igniting various specimens of platinous chloride *in vacuo*, showing that in every case very sensible quantities of hydrogen chloride and oxygen were present. The greatest amount of impurity was found in a specimen derived from the salt prepared by heating hydrogen platinichloride *in vacuo* in a tube containing solid potash, as recommended by Pigeon (*Compt. rend.*, 1892). This last fact and Pullinger's description of his method of preparing anhydrous platinic chloride (*C. S. Trans.*, 1892, 422) led us to conclude that probably a more satisfactory product, at any rate as a source of chlorine, would be obtained by heating hydrogen platinichloride at a high temperature in a current of dry hydrogen chloride.

Experiment I.—Some hydrogen platinichloride was heated at the boiling point of mercury in a current of dry hydrogen chloride during 15 hours, and the hydrogen chloride was then displaced by dry air. A part of the product was ignited *in vacuo*, and the gas which was given off was examined in the manner previously described (*loc. cit.*). We found that the residue from the action of mercury only amounted to 0·156 per cent. This residue was partly soluble in water as before. The gas made in this way therefore contained 99·84 per cent. of chlorine.

Experiment II.—A portion of the product of the first experiment was heated in a current of dry hydrogen chloride at about 500° during many hours, by placing it in a glass tube surrounded by a well-fitting glass jacket immersed in a bath of molten nitre; at the end of the operation, the hydrogen chloride was expelled by means of dry air. The process was rather difficult to carry out, as the complete decomposition of the salt easily takes place if the temperature too much exceeds the melting point of silver chloride, some decomposition occurring even at that temperature.

A portion of the product of this experiment was placed in a glass tube, which was then exhausted as in our previous experiments; it contained no drying material, but both the tube and its contents were heated to drive off moisture. Chlorine was generated from the chloride by igniting it *in vacuo*, and the residual platinum having been removed, one end of the tube was broken under mercury. Although we had intentionally neglected to dry the gas, we were at once struck with the fact that the action between this sample of chlorine and mercury was decidedly less active than in the case of any of the specimens previously examined, and when the action of mercury was at an end so little residue was left that its analysis by the method formerly described seemed useless. The part of the narrow tube which had contained the residual gas was therefore cut off and calibrated: it was thus found that the residue amounted to only 0·06 per cent. of the gas taken. The residue was partly soluble in water.

We have not determined the total chlorine in the platinous chloride made in this way, as we do not think it consisted of pure platinous chloride; it probably contained a little platinum, but as a source of chlorine it seems to be very superior to the product of the more familiar processes.

We have previously suggested that the marked activity of even the most carefully dried chlorine towards mercury is probably due to the presence of impurities in the gas. The sluggish action of chlorine and mercury observed in our second experiment, in which the chlorine employed, though not quite dry, contained much less hydrogen chloride and oxygen than any that we have previously examined, is therefore interesting and suggestive.

Shortly after the publication of our former paper on this subject, Professor Victor Meyer called our attention to the fact that in his later experiments on the density of chlorine he assured himself that the other gases present in the chlorine employed were insufficient in quantity to materially affect the chief conclusion he drew from his results (*Ber.*, **13**, 1721). We are anxious to mention this, although we made no direct reference to the subject in our paper, as one of our remarks might very possibly be supposed to imply the contrary.

DISCUSSION.

Mr. GROVES having asked whether the authors had made any further experiments in the direction of fractionally evaporating liquid chlorine, Mr. SHENSTONE, in reply, stated that by fractionating the liquid they had obtained chlorine which, when tested by mercury, was found to be almost as nearly pure as that obtained from platinous chloride. This chlorine, however, acted rapidly on mercury, even after it had been highly heated. and he was inclined to suspect the presence of traces of oxy-compounds in it. It was worth while mentioning that recently roasted chlorine does not appear to cause the adhesion of mercury to glass in anything like the same degree that ozone or unroasted chlorine does. Whether this is due to a change in the gas or to a change on the surface of the glass he could not say.

*114. "The action of phosphoric anhydride on fatty acids. Part III." By F. Stanley Kipping, Ph.D., D.Sc.

Results of an investigation of the behaviour of some of the fatty acids with phosphoric anhydride have been communicated to the Society in previous papers (Trans., 1890, 532, 980); it is now shown that caprylone, $(C_7H_{15})_2CO$, nonylone, $(C_8H_{17})_2CO$, and myristone, $(C_{13}H_{27})_2CO$, can be easily prepared from the corresponding fatty acids and phosphoric anhydride.

The hydroximes of these ketones, the secondary alcohols obtained from the ketones by reduction and the acetyl derivatives of some of the alcohols have been prepared and characterised, and are described in the papers. It is also shown that mixed ketones of the general formula $R{\cdot}CO{\cdot}R'$ are produced when a mixture of two fatty acids is treated with phosphoric anhydride at a moderately high temperature; the mixed ketone is accompanied by two simple ketones, just as is the case when a mixture of the barium salts of two fatty acids is submitted to dry distillation.

The question of the existence of isomeric modifications of the hydroximes of fatty asymmetrical ketones is briefly referred to.

It would appear from the results described in this paper and from those already recorded, that treatment with phosphoric anhydride is one of the simplest and most rapid methods by which a fatty ketone of the general formula $(C_nH_{2n+1})_2CO$ can be prepared from a fatty acid $C_nH_{2n}O_2$, the product being easily isolated and the yield fairly good, especially in the case of the higher acids.

*115. "Regularities in the melting points of certain paraffinoid compounds of similar constitution." By F. S. Kipping, Ph.D., D.Sc.

Having obtained considerable quantities of many of the fatty ketones $(C_nH_{2n+1})_2CO$, the author was able to prepare and characterise their more important derivatives; *e.g.*, various members of the series of hydroximes $R_2C{:}NOH$, secondary alcohols $R_2CH{\cdot}OH$ and ethereal salts $R_2CH{\cdot}OAc$.

Attention is drawn to certain regularities observed on contrasting the melting points of these compounds; it is also pointed out that the melting points of all ketones of the general formula $C_nH_{2n}O$ cannot be calculated by means of the formula suggested by Mills (*Phil. Mag.*, 1884,), inasmuch as isomeric ketones frequently melt at different temperatures.

DISCUSSION.

Mr. A. R. LING drew attention to the similarity in the melting points of many chlorinated derivatives of *p*-benzoquinone and of the corresponding quinols and their diacetyl derivatives as compared with those of the analogous bromo- and chlorobromo-compounds. The agreement seems to be wanting in the para-dihalogen derivatives, but in all other cases, it is sufficiently close to be remarkable. The displacement of chlorine by bromine is usually attended by a rise in the melting point, but metachlorobromoquinone and its derivatives melt at slightly lower temperatures than the corresponding dichloro-compounds. Only two iodoquinones are known, but their melting points do not exhibit the least similitude as compared with those of their analogues.

116. "Some relations between constitution and physical constants in the case of benzenoid amines." By W. R. Hodgkinson and Leonhard Limpach.

A study of the formyl and acetyl derivatives of certain homologues of aniline shows, amongst other things, (α) that the entry of alkyl groups into the nucleus affects the melting and boiling points in a regular manner; (β) that the conversion of formyl into acetyl also involves an alteration in physical properties in extent the same as that produced by introducing CH_3 into the nucleus in an *ortho-* or *para*-position relatively to the amido-group; and (γ) that the same (or any?) alkyl group entering the nucleus in the meta-positions has *no* effect on melting or boiling point. Several numerical regularities are also apparent.

Thus, taking the melting points of the methylamidobenzenes as first examples:—

Formanilid	46°	Acetanilid	114°
Formylxylid	76	Acetxylid	144
Difference	30	Difference	30

That the introduction of methyl into the meta-position has no influence on the melting point is shown by the fact that the following substances melt at the same temperature within a degree:—

Acetmesidid................	NHAc : Me : Me : Me = 1 : 2 : 4 : 6. M. p. 216°
Acettetramethylamidobenzene.	NHAc : Me : Me : Me : Me = 1 : 2 : 3 : 4 : 6. M. p. 215°.
Acetpentamethylamidobenzene	NHAc : Me : Me : Me : Me : Me = 1 : 2 : 3 : 4 : 6 : 6. M. p. 214—215°.

That the CH_3 of the acetyl has an effect on the ortho- and para-position in the nucleus seems evident, as 1 : 2 : 4-formylxylid has the same melting point as acetanilid (114°). Similarly, 1 : 3 : 5-acetxylid and 1 : 2 : 3 : 4 : 5-tetramethylformanilid have the same melting point, viz., 144°.

The tetramethylformanilid can be imagined as built up of 1 : 3 : 5-formylxylid and 1 : 2 : 4-formylxylid.

Melting point of 1 : 2 : 4-formylxylid	113·5°
,, 1 : 3 : 5 ,, ...	76·5
	190·0
,, formanilid..............	46·0
,, 1 : 2 : 4 : 5-tetramethylformanilid .	144·0

Formylmesidid and acetylxylid, NHAc : Me : Me = 1 : 2 : 6, have the same melting point (176°). In this case, the influence can only be exerted on one position (the para-), as both the ortho-positions are occupied.

Similarly, formylmesidid and 1 : 2 : 3-acetmetaxylid both melt at about 176°, and acetmesidid and 1 : 2 : 3-propionylxylid at about 216°.

As an example of numerical relations, taking formyl compounds, formanilid melts at 46°, pentamethylamidobenzene at 217°: now the melting point of formanilid (46°) *plus* 2(34) = 114°, which is the melting point of formylmetaxylid, NHF : Me : Me = 1 : 2 : 4; again, the melting point of formanilid *plus* 4(34) = 182°, which is the melting point of NHF : Me : Me : Me : Me = 1 : 2 : 3 : 4 : 6.

The formyl compounds of aniline, *p*-toluidine, 1 : 2 : 4-metaxylidine and mesidine form a series:—

Aniline (46°) ; *p*-toluidine (52°) ; 1 : 2 : 4-xylidine (114°) ;
46 = 46 + 6 46 + 6 + 62
mesidine (176°), &c.
= 46 + 6 + 2(62).

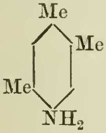
Similarly in the case of the corresponding acetyl compounds:—

Aniline (114°) ; *p*-toluidine (147°) ; 1 : 3 : 4-xylidine (181°) ;
= 46 + 2(34)   = 46 + 3(34)   46 + 4(34)
mesidine (216°).
46 + 5(34).

The different positions are not in all cases of equal value. Thus, pentamethylformanilid melts at 217°, and 46 + 5(34) = 216°, which might indicate equality of the methyl groups, or rather of the positions in benzene. But when CH_2 is introduced into 1 : 2 : 4-xylidine to form mesidine, the melting point rises 62°, so that the formula becomes—

$$\begin{array}{r} 2 \times 34 = 62^\circ \\ 1 \times 62 = 62 \\ 1 \times 46 = 46 \\ \hline 176 \end{array}$$

On introducing methyl into the meta-position, the melting point rises to 182° in the case of 1-amido-2 : 3 : 4 : 6-tetramethylbenzene. The CH_3 groups *appear* again equivalent.

Again, taking away a methyl in the ortho-position leaves a pseudocumidine, 

, melting at 121°, a drop of 62°.

These examples will suffice at present to show that definite relations between melting points apparently do exist in the case of methylamidobenzenes. The authors have examined a number, and are gradually preparing other, alkylamidobenzenes containing ethyl, butyl &c., and find also great regularities from which they hope to be able to state a general law. Many of the published data relating to melting points undoubtedly require careful revision.

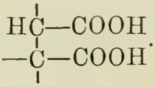
*117. "Electrolysis of sodic ethylic camphorate." By J. Walker, D.Sc.

By electrolysing sodic ethylic camphorate, prepared by the direct union of camphoric anhydride and sodium ethoxide, the author has obtained the ethylic salts of two new acids, $C_8H_{13}{\cdot}COOH$ and $C_{16}H_{28}(COOH)_2$, which he proposes to term *campholytic acid* and *camphothetic acid* respectively.

Camphothetic acid is a colourless, crystalline solid melting at 132°.

It behaves as a saturated bibasic acid, forming well characterised crystalline salts.

Campholytic acid is a monobasic, unsaturated acid. It boils at 240—242°, and is lævorotatory. Its ethylic salt boils at 212°, and is dextrorotatory. Both readily take up bromine in the cold, forming dibromides. The dibromo-acid, $C_8H_{13}Br_2{\cdot}COOH$, is a white, crystalline solid which melts at 110°. Its alkaline salts at once decompose in aqueous solution according to the equation $C_8H_{13}Br_2{\cdot}COONa = C_8H_{13}Br + CO_2 + NaBr$, the compound $C_8H_{13}Br$ being unsaturated, readily uniting with bromine in the cold.

It is pointed out that from the nature of the electrolysis and the above mentioned decomposition of the dibromo-acid, camphoric acid itself must contain the group  $\begin{array}{l} \;\;\;| \\ \mathrm{HC{-}COOH} \\ \;\;\;| \\ \mathrm{{-}C{-}COOH} \\ \;\;\;| \end{array}$.

Discussion.

Dr. Collie having pointed out that the method by which Dr. Walker had obtained campholytic acid was such that there was little probability any fundamental change occurred in the camphoric molecule during the process, Dr. Armstrong said that electrolytic oxygen was probably by no means a mild agent, and he thought that in the present instance, as well as in the cases studied by Crum Brown and Walker, it was not improbable that the change was brought about by oxidation: the formation of unsaturated acids especially favoured this view, as these might be regarded as resulting from the displacement of carboxyl by hydroxyl and the subsequent separation of water, or an analogous set of changes. Dr. Walker's ingenious application of Fittig's conclusions was open to question, on the ground that we knew very little at present of the behaviour of closed chain bromo-acids; moreover, the fact that camphoric acid did not yield a fluoresceïn appeared to preclude the idea that camphoric acid was an acid of the succinic type. He was of opinion that, on the whole, the evidence was in favour of the view that camphoric acid was an acid of the glutaric type, and that Dr. Walker's acid was probably a tetrahydrometaxylene derivative containing the carboxyl in one of the methyls.

Dr. Walker, in reply to Dr. Armstrong, stated that he did not consider it probable that the formation of either the synthetic or unsaturated ethereal salts during the electrolysis was due to oxidation at the anode. Murray had shown in the case of the electrolysis of potassium acetate that there was no sort of proportionality between complete oxidation to carbonic anhydride and "partial oxidation" to ethane, as might be expected if the formation of ethane was due to oxidation. The conditions of the electrolysis found most favourable for the production of synthetic products were such as would almost ensure complete oxidation of the dissolved substance if the primary action was the decomposition of water into oxygen and hydrogen.

*118. "The hydrates of hydrogen chloride." By S. U. Pickering.

The determinations of the densities of solutions of hydrogen chloride made by Kolb, and also some made by the author, show a strongly marked break indicative of the presence of a trihydrate. They are represented by an appreciably straight line from 0 per cent. up to the composition of that hydrate (40 per cent.), after which the deviation from straightness is very considerable. On performing a series of freezing point determinations the trihydrate was obtained in large, transparent crystals melting at −24·9°; this melting point is lowered by the addition of excess either of water or of acid. This hydrate and the dihydrate, already isolated by Pierre and Puchot, are the only crystalline hydrates which were obtained.

The densities indicate the existence of a change of curvature of a very minor character at a point corresponding to the composition of a hexhydrate, and similar indications are noticeable both in Berthelot's and Thomsen's heat of dissolution determinations. The author's freezing point determinations can afford no evidence for or against such a hydrate, on account of there being a change in the crystallising substance at the point in question, but they indicate the existence of a decahydrate. Roscoe and Dittmar's determinations of the influence of pressure on the composition of the boiling acid suggest the presence of an octohydrate. It seems, therefore, probable that these three hydrates exist in solution, and that they are comparatively stable, as solutions of acid of strengths between the hexhydrate and the decahydrate may be distilled with very little change in spite of great variations in pressure, and are altered in composition to a very small extent by the passage of a current of air through them at temperatures between 0° and 100°.

119. "A new base from Corydalis cava." By James A. Dobbie, M.A., D.Sc., and Alexander Lauder.

The authors describe under the name of *corytuberine* a new alkaloid which they have obtained by exhausting crude corydaline with hot water; it crystallises from a hot aqueous or alcoholic solution in beautiful silky needles, soluble in cold solutions of sodium hydrate and ammonia, moderately soluble in benzene, and nearly insoluble in ether and chloroform. When heated it begins to blacken about

200°, and then slowly decomposes without melting. Its aqueous and alcoholic solutions are slightly dextrorotatory. Analyses lead to the formula $C_{19}H_{25}NO_4$. The *chlorhydride*, $C_{19}H_{25}NO_4{\cdot}HCl$, is obtained in small, well formed, rhombohedral crystals when a solution of the base in chlorhydric acid is evaporated to dryness. The *sulphate*, $(C_{19}H_{25}NO_4)_2{\cdot}H_2SO_4$, is obtained by the interaction of the chlorhydride and the calculated quantity of silver sulphate. The *platinichloride*, $(C_{19}H_{25}NO_4)_2{\cdot}H_2PtCl_6$, is precipitated in the form of a pale-yellow, crystalline powder, slightly soluble in water, on adding hydrogen platinichloride to a solution of the chlorhydride in water. Corytuberine is only soluble to a slight extent in methyl iodide, but the methiodide, $C_{16}H_{25}NO_4{\cdot}CH_3I$, can be prepared by digesting an alcoholic solution of the alkaloid with methyl iodide during several hours.

When treated with concentrated solution of hydrogen iodide, one molecular weight of corytuberine gives two molecular proportions of methyl iodide, showing that only two of the oxygen atoms are present as methoxy-groups; corydaline on the other hand has all its four oxygen atoms in this form of combination.

The authors also give some notes on yet another alkaloid which they consider to be distinct not only from corydaline and corytuberine but from all the bases of *Corydalis cava* hitherto described.

EXTRA MEETING.—February 20th, 1893. The Right Hon. Lord Playfair, K.C.B., LL.D., F.R.S., Vice-President, in the Chair.

Kopp Memorial Lecture.

120. "The life work of Hermann Kopp." By T. E. Thorpe, D.Sc., F.R.S.

Kopp was barely 32 years of age when, so far back as 1849, he was elected a Foreign Member of the Society. Born, October 30, 1817, at Hanau, at 18 he proceeded to Heidelberg, where he studied chemistry under Leopold Gmelin. He graduated at Marburg in 1838, the thesis which he presented being on "A method of predetermining the density of the oxides," a proof that he had already, when barely 21 years of age, been attracted by the problems which were to constitute the chief experimental labours of his life. From Marburg he went to Giessen, where, at Liebig's instigation, he studied the mode of decomposition of mercaptan by nitric acid, practically the only investigation in pure chemistry that Kopp ever published.

In 1841 he became Privat-Docent at Giessen, and was appointed

Extraordinary Professor in 1843. In 1852, on Liebig's removal to Munich, Kopp and Will were together made Ordinary Professors, but after a year he resigned the whole control to his friend and colleague, continuing, however, to work in the laboratory. He remained at Giessen nearly five-and-twenty years, and all his most important experimental work was done there. In 1863 he accepted a call to Heidelberg, and repeated attempts to induce him to accept a position elsewhere were unavailing; "even Bunsen alone," he was wont to say, "keeps me fast in Heidelberg."

Kopp is best known to the literary world by his *History of Chemistry*, the first volume of which appeared in 1843, and the fourth and last in 1847. Hofmann, his life-long friend, has told us that by the publication of this classical work, Kopp—then barely 30 years old—suddenly found himself famous. Much of the later historical matter he published grew out of materials collected for the preparation of an enlarged and improved edition of the great work, which Kopp postponed year after year in the hope of being able to make a further study of certain special periods.

On the death of Berzelius, in 1848, the leaders of the Giessen school determined to carry on the work which had mainly occupied the closing years of his life, and established *Liebig and Kopp's Jahresbericht*, which Kopp continued to edit until 1862. In 1851 he joined Liebig and Wöhler in the production of the *Annalen der Chemie und Pharmacie*, and his name appears on the title page of no fewer than 190 volumes of this famous periodical. He also found time to write his *Introduction to Crystallography*, the section on Theoretical Chemistry in Graham Otto's *Lehrbuch*, and not a few minor essays.

As an investigator, he occupies an almost unique position, the one consistent purpose of his work having been to establish a connection between the physical and chemical nature of substances—to prove, in fact, that all physical constants are to be regarded as functions of the chemical nature of molecules. When he began his enquiries very few boiling points were known even approximately; the thermal expansions of barely half-a-dozen liquids had been measured, and the very methods of making such measurements with precision had to be worked out. In fact, at the outset of his investigation, he found the physical constants with which he was more immediately concerned very much as Berzelius found Dalton's values of the relative weights of the atoms.

His more important memoirs naturally fall into comparatively few groups:—viz., 1, those concerning the relations between the relative densities of substances and their molecular weights; 2, those treating of the relations between boiling points and chemical composition; and, 3, those relating to the specific heats of solids and liquids.

In nothing was his originality and ingenuity more strikingly manifest than in the construction of his apparatus; to a great extent he was his own instrument maker, and his materials were for the most part glass and cork; but no Japanese worker with his few and primitive tools ever produced results which in point of delicacy, finish and accuracy surpassed those which Kopp obtained by means of his simple contrivances.

In discussing Kopp's various investigations, Professor Thorpe first considers his work on specific heats and its bearings.

His observations on the relation of boiling point to composition are next discussed, and the various later observations of other enquirers are taken into account.

Kopp's researches on specific volumes form the last section of the lecture, this subject being dealt with in a very comprehensive manner, not only Kopp's work but also that of subsequent observers being fully taken into account, the historical development of the subject being explained and abundantly illustrated.

It is pointed out that by the examination of the very large quantity of experimental material which is now before us, we are driven to the conclusion that molecular volume is not a purely additive property. There is no longer room for doubt that the molecular volumes of substances are affected by far more conditions than we have hitherto taken cognizance of. The value $CH_2 = 22$ has no other significance than as expressing the average increment in volume in successive members of an homologous series: it is doubtful whether even this mean value is correct; later observations appear to show that the value augments as the series is ascended. The relation $C = 2H$ no longer applies to carbon compounds in general. What is true of carbon and hydrogen is equally true of oxygen, whether as carbonyl or as hydroxyl oxygen: no definite or uniform values can be assigned to oxygen such that the molecular volume of a liquid can be *a priori* determined. The values given by Kopp are simply mean values, but the actual volumes are affected by conditions of which as yet we have no very precise knowledge or any certain means of measuring. The values for other elements are affected by the same considerations: that of chlorine, for example, as it is obtained on the assumption that the values for carbon and hydrogen are constant.

At the conclusion of this section reference is made to Kopp's critical memoir on the subject, published in *Liebig's Annalen* shortly before his death, discussing the outcome of the various researches which followed his own: we rise from its perusal, says the lecturer, with the conviction that after all the work summarised takes us but little beyond the threshold of the fundamental truth of which Kopp was the first to perceive the indication.

Lord Playfair, in the course of his remarks at the conclusion of the lecture, mentioned the fact that he had known Kopp 52 years ago—they were pupils together under Liebig. He was with him when he was making his first specific volume determinations, and Kopp daily came to him to discuss the results. In the historical survey given by the lecturer there seemed to be one name missing, that of Dalton; it was by reading a memoir by Dalton on specific volumes of solutions—a memoir which was rejected by the Royal Society and published privately—that he had been led to pay attention to the subject: this memoir was full of suggestions.

Dr. Gladstone had known Kopp as far back as 1847–48, when he worked in Liebig's laboratory. Kopp's individuality undoubtedly in those days exercised a strong influence over the students.

Professor Rücker spoke of the publication of memoirs describing the life work of men like Kopp and discussing its bearings and development as a very happy idea on the part of the Society and as likely to be of great value to scientific workers.

HOFMANN MEMORIAL LECTURE.

An extra meeting of the Society will be held on Friday, May 5th, 1893, the anniversary of the death of A. W. von Hofmann, when addresses will be delivered by the Right Hon. Lord Playfair, K.C.B., F.R.S., V.P.C.S.; Sir F. A. Abel, C.B., F.R.S., V.P.C.S.; Dr. W. H. Perkin, F.R.S., V.P.C.S.

Meetings of the Society during the remainder of the Session.

Thursday, March 2, 16.
***Monday, „ 27.**
†Thursday, April 20.
„ May 4, 18.
‡Friday, „ 5.
Thursday, June 1, 15.

* Annual General Meeting.
† It is proposed that there shall be no meeting in Easter week.
‡ Hofmann Memorial Lecture.

At the next meeting, on March 2nd, the following papers will be read :—

"Notes on optical properties as indicative of structure" (postponed). By H. E. Armstrong.

"The ethereal salts of active and inactive glyceric acid." By Professor P. Frankland and J. MacGregor.

"The limits of accuracy of gold-bullion assay and the losses of gold incidental to it. The volatilisation of gold." By T. K. Rose.

"The interaction of alkali-cellulose and carbon disulphide. Cellulose thiocarbonates." By C. F. Cross, E. J. Bevan and C. Beadle.

"A new atomic diagram and periodic table of the elements." By R. M. Deeley.

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Issued 15/3/1893.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

No. 121. Session 1892–93.

March 2nd, 1893. Dr. J. H. Gladstone, F.R.S., Vice-President, in the Chair.

Messrs. T. K. Rose, K. K. Kacker and C. M. Luxmoore were formally admitted Fellows of the Society.

It was announced that the following additions to the bye-laws proposed by the Council would be presented for consideration at the coming General Meeting:—

1.—In Bye-Law XI, after the words "The ordinary Scientific Meetings of the Society shall be held twice in every month, from November to June inclusive, except in the month of January, when the Society shall meet once only," to add the words "and also at Easter, when, if the Council see fit, there shall also be only one meeting in the month."

2.—In Bye-Law XIII, to add the following paragraph:—

> "At all General Meetings of the Society, whether annual or extraordinary, no motion of a proposal to alter the bye-laws shall be considered of which due notice has not been given, at least 14 days previously, either at an ordinary Scientific Meeting, or through the agency of the "Proceedings," or by means of a printed notice addressed to all the resident Fellows."

Attention was directed to the following resolutions passed at a meeting held on March 1st, 1893, at the Royal Agricultural Society's rooms, H.R.H. the Prince of Wales, K.G., in the chair:—

> "That, having regard to the great national importance of the series of experiments which have been carried on at Rothamsted during the last 50 years, it is desirable that some public recogni-

tion should be made of the invaluable services thus rendered to agriculture by Sir John Lawes, and also by Dr. Gilbert, who has been associated with the experiments during the whole period.

"That, with this object, subscriptions, to be limited to two guineas, be invited from all interested in agriculture, whether scientific or practical.

"That, in the opinion of this meeting, the testimonial might advantageously take the form of (1) a granite memorial, with a suitable inscription, to be erected at the head of the field where the experiments have taken place; (2) addresses to Sir John Lawes and Dr. Gilbert, accompanied (if funds permit) by a commemorative piece of plate."

Ordinary certificates were read for the first time in favour of Messrs. John Charles Burnham, 179, Griffin Road, Plumpstead; James Cameron, Nobel's Explosive Co., Polmont Station, A.B.; Henry Williamson Dixon, 258, Hunslet Road, Leeds; Thomas Edwards, Brewery House, Rhymney; Hedley Gordon Jones, 15, Rectory Place, Woolwich.

Of the following papers those marked * were read:—

*121. "The magnetic rotation and refractive power of ethylene oxide." By W. H. Perkin, Ph.D., F.R.S.

The following values are recorded in the paper:—

d 4°/4° = 0·8909; d 7°/4° = 0·88654; d 7°/7° = 0·8867; d 10°/10° = 0·8824.

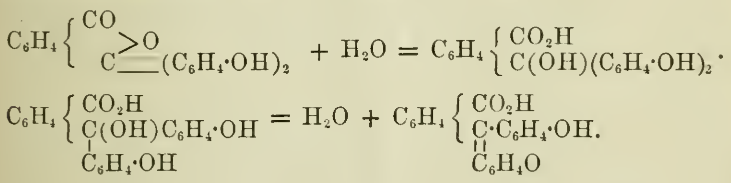
Molecular magnetic rotation at 8° = 1·935.
Molecular refraction at 7°, A = 17·680.
Dispersion, G − A = 0·5494.

It is pointed out that the magnetic rotation is most remarkably low, and the refractive power also below the calculated value (A = 18).

*122. "The origin of colour (including fluorescence). VII. The phthaleins and fluoresceins." By Henry E. Armstrong.

In the first of these communications on the origin of colour (these Proceedings, 1888, No. 4, p. 27), exception was taken to the formulæ assigned to phenolphthalein and its congeners. Although the exhibition of colour by these substances could not be accounted for by the formulæ ascribed to them, the data then available were insufficient to permit of more satisfactory formulæ being devised. The subsequent discovery of the rhodamines strengthened this conviction, and the intention to make these the subject of experimental study as soon as an opportunity occurred has long been kept in mind; fortunately this is no longer necessary, the technical value of these substances having led to their further investigation in various works laboratories, with the result that they have been shown, as was anticipated, to exhibit properties proving that they also are quinonoid compounds.

The *Chemiker Zeitung*, No. 104, December 28, 1892, contains an account of a communication made to the Heidelberg Chemical Society on December 16, by Professor Bernthsen, who points out that the rhodamines afford true ethereal salts when subjected to the conjoint action of alcohol and chlorhydric acid: in other words, that they afford carboxy-compounds and not lactone derivatives. After directing attention to other evidence in favour of the view that the colours of this class are members of the triphenylmethane group, he points out, in so many words, that the characteristic development of colour on adding alkali to phenolphthalein is, in all probability, due to the fact that the colourless lactone phenolphthalein is thereby hydrolysed and converted into a quinolic compound, which suffers dehydration, affording a coloured quinonoid compound:



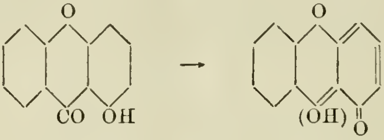
$$C_6H_4\left\{\begin{array}{l}CO\\ \quad >O\\ C\underline{\quad}(C_6H_4\cdot OH)_2\end{array}\right. + H_2O = C_6H_4\left\{\begin{array}{l}CO_2H\\ C(OH)(C_6H_4\cdot OH)_2\cdot\end{array}\right.$$

$$C_6H_4\left\{\begin{array}{l}CO_2H\\ C(OH)C_6H_4\cdot OH\\ |\\ C_6H_4\cdot OH\end{array}\right. = H_2O + C_6H_4\left\{\begin{array}{l}CO_2H\\ C\cdot C_6H_4\cdot OH.\\ \|\\ C_6H_4O\end{array}\right.$$

In a more recent paper (*Berichte*, 1893, 172), Friedländer—who does not appear to be aware of Bernthsen's communication—has stated that phenolphthalein and hydroxylamine readily interact in an alkaline solution and form a hydroxime; this and other evidence he mentions leads him to express the opinion that in their coloured state phenolphthalein and the allied phthaleins which behave similarly in presence of alkali are all *quinonoid* compounds.

But, as so frequently happens at the present day, the patent literature contains statements which anticipate the views of Bernthsen and Friedländer, *e.g.*, a description being given of the formation of ethereal salts of rhodamines by the action of alcohol and chlorhydric acid in the French patent specification No. 224603, of the "Farbenfabriken vormals Friedr. Bayer und Co." (Elberfeld), dated September 28, 1892. It is pointed out in this specification that the rhodamines are to be regarded as carboxylic compounds, and the absence from the ethereal salts of the property which the rhodamines exhibit of forming salts and lakes is referred to as confirmatory of this view.

Friedländer is led to regard the fluoresceins as perhaps different from the phthaleins, as he was unable to obtain hydroximes from them, and speaks of their colour as conditioned by their xanthone-like structure. There appears to be no reason, however, why a distinction should be drawn between the intensely fluorescent rhodamines and the analogous oxygenated compounds—the fluoresceins. Even regarding them as xanthone derivatives, the appearance of colour in these latter is, it can scarcely be doubted, consequent on the occurrence of isodynamic change (*cf.* these Proceedings, 1892, 103).



Colourless. Coloured.

The problem, therefore, remains practically the same; nevertheless, there can be little doubt that the phthalein-fluorescein group still offers interesting matter requiring further study.

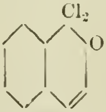
Perhaps the point of chief interest claiming attention is the extraordinary ease with which the hydrolysis of the lactone is effected in the case of phenolphthalein, as evidenced by the fact that it is among the most sensitive of the known indicators of alkali: in contemplating the changes which may attend the dissolution of substances by water, such facts are undoubtedly of high importance. Perhaps the change is less a consequence of the instability of the lactone ring, and is mainly conditioned by the hydroxyl present in the para-position relatively to the carbon atom to which the phenolic radicles are attached—it is conceivable that a hydrated metallic derivative of the phenol is initially produced, and that the metal and water necessary to effect the hydrolytic change are thus brought into the intramolecular sphere of interaction. From this point of view, it would be interesting to determine the degrees of readiness with which phthalid and its various derivatives undergo hydrolysis. It is also worth noticing that, according to Bernthsen, the anhydrous rhodamine base forms a colourless solution in benzene and may be obtained in large, colourless crystals, while its solution in water is coloured and it forms an intensely coloured pentahydrate.

The recognition of the quinonoid character of such eminently fluorescent substances as the fluoresceins and rhodamines may be claimed as a most important argument on behalf of the view that fluorescence is a form of colour: indeed that—taken in conjunction with other facts—it goes far towards justifying the contention that all quinonoid derivatives would be visibly fluorescent, were it not that, as in the case of certain quinine salts, as Hartley has pointed out, the rays which are the cause of the fluorescence sometimes become absorbed in the solution.

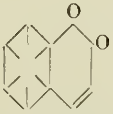
*123. "The origin of colour. VIII. The limitation of colour to truly quinonoid compounds. Change of colour as indicative of change of structure, as in the case of alizarin." By Henry E. Armstrong.

A quinonoid compound may be defined as a *hexaphene*, *i.e.*, an unsaturated cycloid composed of six "elements" (*cf.* these Proceedings, 1892, 129), two "elements" of which are C○R″ groups in either para- or ortho-positions.

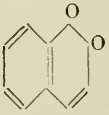
Coloured substances generally appear to fall within this definition, as there do not appear to be any established cases of the existence of coloured substances—(*a*) containing a single C○R″ group, or (*b*) in which two such groups are present in a cyclane or saturated ring, or (*c*) in which the cycloid contains any other number of elements than six. The succinosuccinic derivatives, &c., are but apparent exceptions to *b*, as those which are coloured may be regarded as isodynamic forms of the saturated compounds. Diacetyl and dibenzoyl (benzil) may be mentioned as exceptions to the general definition, but for this very reason it appears likely that they will eventually be obtained colourless; it is easy to account for the appearance of colour in diacetyl, as it undergoes condensation with extreme facility, yielding dimethylquinone (paraxyloquinone), an intensely yellow substance. Such a change is not likely to occur in the case of benzil, but this compound is so faintly yellow that the colour may well be due to impurity.

Some of the keto-chlorides described by Zincke appear to be exceptions to *a*, *e.g.*, the compound  , prepared by chlorinating betanaphthol, the colour of which is a yellow of considerable intensity, and there is no reason to suppose that this is not characteristic of the pure compound. It is not improbable, however, that the group CCl_2 in this and similar substances may be the true equivalent of a C○R″ group. In an article on "The determination of the constitution of carbon compounds from thermochemical data," published in the *Phil. Mag.*, in February, 1887, summarising and briefly discussing the results described in the fourth volume of J. Thomsen's *Thermochemische Untersuchungen*, it was suggested that the greater development of heat which attends the formation of symmetrical dichloro-derivatives may be due to the partial neutralisation of the (residual) affinity of the one chlorine atom by the other: in other words, that chlorine atoms are possessed of the power of directly entering into association while combined with another atom; in which case 2Cl would be the equivalent of R″.

As the presence of two ortho- or para-carbonyl groups in a saturated ring apparently does not condition colour, it would seem that the two $\mathrm{C}\overset{\frown}{\smile}\mathrm{R}''$ groups are concerned *together with* the "ethenoid linkages" in the unsaturated ring in the production of colour; hence, the fact that compounds such as the naphthaquinones and the ketochloride before referred to are coloured is of importance, as evidence that *perhaps* a single ethenoid linkage in the ring is sufficient, and that it is not necessary that there should be two such, symmetrically situated with reference to the two $\mathrm{C}\overset{\frown}{\smile}\mathrm{R}''$ groups as in the benzoquinones; this, however, is on the assumption that the naphthaquinones are derivatives of *centric* and not of *ethenoid* benzene, hence the perhaps; the importance of this consideration will be more clearly realised after reference to the arguments made use of in the two following notes:—

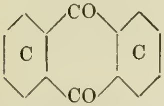


"Centric" β-naphthaquinone.



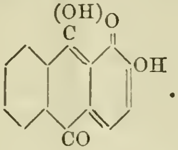
"Ethenoid" β-naphthaquinone.

Anthraquinone—which, it may be remarked, has scarcely any of the properties of a true quinone—may be referred to in this connection: if represented as a derivative of *centric* benzene, thus,



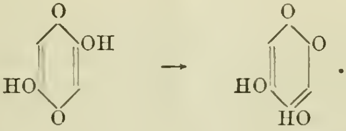
, the median group would appear to be saturated; yet, as anthraquinone may be regarded as formed by the superposition of benzene and quinone, it would seem that the median group is still possessed of quinonoid characteristics; unless it be that the effect of the two CO groups is supplemented by that of the two symmetrically placed centric cycloids.

It would seem appropriate to here direct attention to the colour of alizarin in comparison with that of anthraquinone. The colour of paraquinones and their derivatives, in all cases in which the structure appears to be in no way open to question, is uniformly yellow; and red is characteristeristic of orthoquinones. How comes it then that alizarin is red? The conventional formula is not in accord with this fact, but the colour may be accounted for by regarding alizarin as an isodynamic form of dihydroxyanthraquinone, *e.g.*,



On this assumption there is no difficulty in understanding why the monhydroxyanthraquinones are of no use as dye-stuffs ; and why the introduction of two contiguous hydroxyls into anthraquinone is of such importance ; furthermore, it is to be expected that a monethoxy-derivative prepared from alizarin if it contained an α-ethoxy-group would resemble anthraquinone while one containing a β-ethoxy-group would more nearly resemble alizarin in colour : and, as a matter of fact, two such compounds have been described, one of which is yellow and the other red.

In like manner, it may be suggested as probable that the chloranilates are not derivatives of paraquinone, and that their formation involves the occurrence of isodynamic change, thus :—

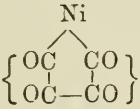


The arguments advanced in proof of their paraquinonoid nature do not appear to be in any way conclusive. Lastly, reference may be made to the *phenoquinones* and *quinhydrones:* it is difficult to regard these as being other than members of that ill-understood and vaguely-defined class of substances termed molecular compounds. If so, the changes in the colour of quinones involved in their formation may arise from the weighting of the $\mathrm{C}\bigcirc\mathrm{R}''$ groups by the attachment thereto of the phenol.

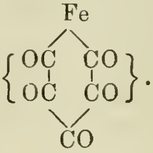
*124, "Note on optical properties as indicative of structure." By Henry E. Armstrong.

In his "Notes on some recent determinations of molecular refraction and dispersion," recently communicated to the Physical Society (*Phil. Mag.*, 1893, 203), Dr. Gladstone directs atttention to a number of curiously suggestive observations of special interest in connection with the all-fascinating enquiry into the correlations of properties and structure. The metallic carbonyls to which he refers, in respect of physical properties as in many other respects, are compounds of extraordinary interest. The conclusion which both Mond and Gladstone favour that they are cycloids is undoubtedly that most in harmony with their general behaviour, affording as it does an explanation of the complete masking of the metal, comparable, for example, with that which sulphur suffers in thiophen.

The excessive refractive and dispersive power which the metallic carbonyls exhibit is probably, as Gladstone suggests, to be sought in the peculiar arrangement of the carbonyls; one object of this note is to call attention to the evidence which the optical data apparently afford of their *cooperative action.* The ketonic compounds hitherto studied from which the value $CO = 8{\cdot}4$ has been derived have been compounds containing single or isolated carbonyls, whereas—if represented as cycloids—the metallic carbonyls contain two "ortho-systems," thus—



ortho-system.



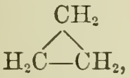
In this sense, they are in fact diorthoquinonoid and are comparable with coloured substances, but they are not truly quinonoid, the cycloid being saturated, and hence should not be coloured. (The nickel compound is colourless, but the iron compound is described as yellow; the instability of the latter, however, is such that this colour may be due to impurity.) There are only two orthoquinonoid systems, although there are five carbonyls in iron pentacarbonyl, so that one of the carbonyls should have the ordinary value and only four the value they apparently exhibit in nickel tetracarbonyl (11·9): consequently the molecular refraction should be

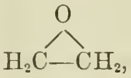
$$\begin{array}{lrr} 4CO\ (\text{orthoquinonoid}) = 4\,.\,11{\cdot}9 & = & 47{\cdot}6 \\ CO\ (\text{ketonic}) & = & 8{\cdot}4 \\ Fe'' & = & 11{\cdot}6 \\ \hline & & 67{\cdot}6 \end{array}$$

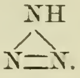
a value not far removed from that found, viz., 67·4.

If this argument be a sound one, it is to be anticipated that quinonoid compounds generally will be found to possesses specially high refractive powers; and there is some evidence that this is the case: thus among the compounds examined by Gladstone (*C.S. Journ.*, 1870, 101—147; Trans., 1884, 241) anthracene—a hydrocarbon which, as more than once pointed out, is probably quinonoid in struc ture—is credited with a very high value, considerably above that calculated even if the value 6·1 be assigned to carbon. Gladstone has also stated that β-nitraniline has an abnormally high refractive power. I learn from Professor Mills that the compounds referred to as α- and β-nitraniline which he gave to Gladstone were the meta- and para-derivatives; apparently, therefore, this result is in accord with the view previously advocated (these Proceedings, 1892, 101) that paranitraniline and similar *coloured* nitro-compounds are in reality quinonoid. Dr. Gladstone states, however, that both substances were examined in weak solutions, and, therefore, less than the usual confidence can be felt in the accuracy of the data.

Liveing and Dewar's determination of the molecular refraction of nitrous oxide in the liquid state is also referred to by Gladstone, who points out that the value observed (11·418) favours the view that the nitrogen in nitrous oxide has the low value which this element exhibits in nitriles, viz., 4·1. The determination of the structure of nitrous oxide is of special importance, as it is one of a group of compounds, including trimethylene, ethylene oxide and diazoimide, all of which it is the fashion at the moment to formulate as cycloids:—







But, apparently, there is no valid evidence to justify the practice, and it is in no way necessary to adopt such a course. Unfortunately we are without knowledge of the optical properties of trimethylene, but we have J. Thomsen's remarkable observation that its heat of combustion exceeds that of the isomeric propylene by 6690 units. I have on several occasions discussed the properties of this hydrocarbon and have pointed out how its unique behaviour with bromine and bromhydric acid may be explained by electrolytic considerations (*cf.* Morley and Muir's *Watts' Dictionary of Chemistry*, **3**, Art. "Isomerism.") Granting the accuracy of Thomsen's figures, there appears to be no way of avoiding the conclusion that it is an open chain hydrocarbon, and, therefore, that free affinities may exist at the end of a chain; its dissimilar behaviour towards bromine and bromhydric acid precludes the application of von Baeyer's explanation of the instability of a ring of three atoms, as such a ring should prove unstable to bromine as well as to bromhydric acid, the former being in all other cases the more active agent in attacking hydrocarbons.

Ethylene oxide, in like manner, has an abnormally low heat of formation; in fact, on this account, J. Thomsen has gone so far as to represent it by the formula $CH_2\cdot O\cdot CH_2$, an expression offending against all recognised canons. If, however, trimethylene be written

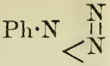
$CH_2{\cdot}CH_2{\cdot}CH_2$, ethylene oxide may be written $CH_2{\cdot}CH_2{\cdot}O$. Perkin's results, referred to in a previous note (*ante*, p. 52), show that it is abnormal in its optical behaviour; they are most significant as affording evidence—assuming an open chain formula—that the optical effect of free affinities is below the normal, and it may be anticipated that trimethylene will afford low values. It is worth noting that carbonic oxide, in which we believe that certain of the affinities of the carbon atom, if not free, are "self engaged," has a molecular refraction (7·5) considerably below the value of CO in ketonic compounds: it would seem that the ordinarily accepted refraction equivalents are not to be regarded as measures of the effect of the "affinities" proper, but of the affinities *engaged between atoms*.

Passing now to the nitriles and nitrous oxide, we have the most indefinite ideas as to the former: they are conventionally represented as compounds of triad nitrogen, but this practice is but the outcome of formal obedience to certain artificial and dogmatic rules of valency, and has no real justification. As we must admit the existence of latent affinities in carbonic oxide—which may be written <CO—we may also admit the possibility of their existence in nitrogen, and may represent the nitriles as compounds of the form $<\overset{\overset{X}{|}}{C}—N>$. Nitrous oxide, on this assumption, would be <N—O—N>. Diazoimide might, in like manner, be regarded as <N—NH—N>, a formula which is implied in Mendeleef's assumption that it is a dinitrile. No diazoimide derivatives have hitherto been examined: Dr. Perkin had the kindness to determine the refractive power of the phenyl derivative, of which a quantity was placed at my disposal by Professor Tilden: the results are as follows:—

d 10°/10° 1·0980; *d* 15°/15° 1·09318; *d* 25°/25° 1·08527.

	t.	*n*.	$\frac{n-1}{d}$.	$\frac{n-1}{d}$ P.
A.......	11·7	1·54719	0·49943	60·431
C	,,	1·55407	0·50571	61·191
D.......	,,	1·56063	0·51170	61·916
F	,,	1·57793	0·52749	63·826

Deducting from the value of aniline, 52·09, the value of two hydrogen atoms, 2·6, and adding twice the highest value of nitrogen, 2 . 5·1, the theoretical value is A = 59·89, which is lower by 0·54 than that found; so that diazophenimide has proportionally a somewhat higher molecular refraction than even aniline.

These results do not indicate that diazophenimide is a dinitrile; neither is it possible to deduce from them any special argument in favour of the formula  $\mathrm{Ph{\cdot}N}<\begin{array}{c}\mathrm{N}\\ \|\\ \mathrm{N}\end{array}$: the problem, in fact, remains unsolved.

Consideration of the facts makes it appear probable that a solution of the difficulty *may* be found, and not only so, but that it may be possible ere long to carry on the enquiry into the interrelationship of structure and physical properties on more fruitful lines than has of late been possible.

In the case of parraffinoid compounds generally, both carbon and hydrogen seem to have a fixed optical value, and it may be supposed also that this is true of hydrogen in all cases; seemingly also, *ethenoid carbon*—carbon as it is in ethylene, whatever may be the mode in which the atoms are united—has a constant value. The variations which are noticed in paraffinoid and ethenoid derivatives must on these assumptions be ascribed to variations in the radicles displacing hydrogen; and it should be easy therefore, by studying a considerable number of properly chosen compounds, to determine which radicles are, and which are not, subject to variation and the circumstances which condition variation.

In the case of benzenoid compounds, there is no evidence of constancy. Even in the case of the hydrocarbons, the value of the C_6 group rises from $C = 6$ (very nearly) in benzene to $C = 6{\cdot}15$ in mesitylene, the only apparent alteration made consisting in introducing methyl in place of hydrogen. As all the evidence derived from the study of paraffinoids seemingly shows that CH_3 has an invariable value, it is only logical to suppose that the variation arises in the cycloid; in other words, that whereas the ethenoid C_2 system apparently has an invariable optical effect, the benzenoid C_6 system has a variable optical effect. There is nothing surprising in this conconclusion—it is in absolute accordance with the experience derived from the study of the chemical behaviour of the benzenoid compounds. The variation, in many cases, is very considerable: that of aniline, for example, which has a molecular refractive power $A = 52{\cdot}09$. Assuming NH_2 to be $5{\cdot}1 + 2 \,.\, 1{\cdot}3 = 7{\cdot}7$, and deducting the value of $5H = 6{\cdot}5$, the value of C_6 in aniline is $52{\cdot}09 - 7{\cdot}7 - 6{\cdot}5 = 37{\cdot}89$, and $C = 6{\cdot}31$. There is no reason why the value should not be still higher in diazophenimide: to determine the value of the N_3, either N_3H or one of its paraffinyl derivatives should be examined. The chemical properties of diazophenimide are such—its nitro-derivatives are hydrolysed with such facility—as entirely to justify the assumption that the N_3 has a very special influence on the properties of the cycloid.

The strongest confirmation of the view here put forward is afforded by diphenyl, in which each carbon apparently has the value 6·39: the two radicles of which this hydrocarbon is composed being alike, and being both benzene residues and directly conjoined—putting the hydrogen aside—there can be no question that the variation is due to the variation in the optical effect of the C_6 group.

If it can thus be shown either that the ethenoid group has an invariable effect whatever number of such groups may be present in the compound or that its effect is invariable except in certain cases in which a co-operative effect is traceable, and the benzenoid group be proved to have a variable optical effect, the most absolute demonstration will have been secured of the existence in benzenoid compounds of a peculiar structure such as is foreshadowed in the centric formula first proposed by me in February, 1887.

The following may be referred to as illustrative of the problems requiring consideration. Among haloid compounds, methylene iodide is altogether peculiar, its refraction equivalent (58·22) being much above the calculated value (52·1); this may be a case of co-operative action. The high dispersive power of carbon bisulphide is perhaps to be accounted for in some such manner. In iodoform, an eminently remarkable substance on account of its *colour* and other exceptional properties, the third iodine atom appears to exert an influence comparable with that of an ethenoid group in quinone and to determine the appearance of colour. In this case the effect is seemingly produced within the sphere of affinity around the carbon atom, much as in the case of quinonoid compounds it is produced within the cycloid sphere of affinity. Bromopicrin, if the value found by Gladstone be correct, appears to be an example involving a negative influence, a cause which, perhaps, also prevails in the case of acetylenic compounds, the abnormally low refractive power of which is highly remarkable. The aldehydes offer many peculiarities. It is to be remembered that Thomsen has represented aldehyde as $CH_3{\cdot}C(OH)$; the oxygen in such a compound would have a lower value than in ketones, but the one atom of carbon, being in the carbonic oxide or dyad state, would probably have a lower value than 5: so that, by assigning the full value to both carbon atoms and the ketonic value to oxygen, the equivalent would be over-estimated. But no indication that such is the case is actually afforded by aldehyde.

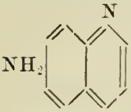
The refraction equivalent of benzaldehyde is about two, and that of salicylic aldehyde about three, units above the calculated value; this may be due to an increase in the cycloid value, but it is conceivable that the cycloid and the ketonic groups in some way co-operate; and it is even possible to represent salicylic aldehyde as a quinonoid compound. It is noteworthy that both these aldehydes are very active substances, and prone to yield condensation products. Cinnamic aldehyde is one of the most refractive and dispersive of known substances, and its refraction equivalent (75·3) is much above the calculated value, 65·4. It may be represented as $C_6H_5\cdot CH\overset{\frown}{\smile}CH\cdot C\overset{\frown}{\smile}OH$, or even as $C_6H_5\cdot CH\overset{\frown}{\smile}C\overset{\frown}{\smile}CH\cdot OH$, and it would seem probable that the high refractive power is conditioned by a co-operative influence of the contiguous cycloid and ethenoid groups. From this point of view, it is important to examine allene, $CH_2\overset{\frown}{\smile}C\overset{\frown}{\smile}CH_2$. Stilbene, $C_6H_5\cdot CH\overset{\frown}{\smile}CH\cdot C_6H_5$, is another equally striking instance, its refraction equivalent (113·39) being also very much higher than the calculated value (101).

The arguments here made use of in correlating optical properties and structure are undoubtedly applicable to the discussion of other physical properties, and, as some of these are apparently the measure of intra- and others of extra-molecular effects, it is all important that a careful comparison should be made with the object of elucidating reciprocal relationships.

In conclusion, attention may be directed to the *anomalous colour dispersion* displayed by rosaniline and other colouring matters. In these compounds the two $C\overset{\frown}{\smile}R''$ groups are of totally distinct types, and apparently the effect has not been noticed in the case of compounds in which the quinonoid groups are alike or similar. Biot has shown that the phenomena of anomalous *rotatory* dispersion exhibited by tartaric acid solutions are simulated by a mixture of two optically active mutually indifferent substances having different rotatory dispersive powers; it seems not improbable that the two dissimilar quinonoid groups which condition colour in rosaniline and substances which behave like it condition anomalous colour dispersion in consequence of their dissimilarity.

125. "The origin of colour. IX. Note on the appearance of colour in quinoline derivatives and of fluorescence in quinine." By Henry E. Armstrong.

The arguments put forward in the previous note have far-reaching consequences. The increase in refractive power observed on comparing the homologues of benzene with benzene might be ascribed to a passage from the centric to the ethenoid form—assuming the former to have a slightly lower optical value than the latter; and such a view would be in accordance with the observed change in chemical behaviour, but it would not account for the change in the case of aniline and other compounds, as the optical value of carbon in these rises above that which is seemingly characteristic of the ethenoid form.

That the change takes place in some cases, there can be little doubt, especially when von Baeyer's researches are taken into account. The object of the present note is to point out that its occurrence would account for the appearance of fluorescence and colour in quinoline derivatives which has been discussed in a previous note (these Proceedings, 1892, 143). Assuming quinoline to be a centric cycloid and that the introduction of NH_2 has a very marked effect, as in the case of aniline, it is possible that the compound may thereby be caused to acquire an ethenoid structure; but such an ethenoid compound would be quinonoid, as may be seen on reference to the formula 

; in other words, any amido-derivative of quinoline might be quinonoid, and therefore coloured, probably either orange or red.

In like manner, an ethenoid form of naphthalene would be quinonoid; it is, therefore, possible that the fluorescence exhibited by many naphthol and naphthylamine derivatives is characteristic of the pure substances, and does not always originate in impurities.

If the argument here used be justified, the non-appearance of colour and fluorescence in naphthalene derivatives will afford evidence of a centric structure similar in character to that which the peculiar optical behaviour of benzenoid compounds affords of a special structure different from the ethenoid form in benzene.

DISCUSSION.

The CHAIRMAN (Dr. Gladstone) said that he would like to consider the suggestive remarks of Professor Armstrong on molecular refraction more carefully before committing himself to a definite opinion; the idea of a "co-operative influence," such as had been put forward, was, he thought, worthy of all attention. It had long struck him as an unexplained phenomenon, that while in the aromatic substances in general 6·1 is indicated as the atomic refraction of each of the double-linked carbons, the value was very appreciably lower in benzene itself and in toluene; and that when the compound becomes very complex, the value becomes larger than 6·1. Thus aniline is certainly more refractive than would be anticipated from the usual run of benzene compounds and compound ammonias. Carbon in such compounds as naphthalene or phenanthrene has a much higher refractive power, to which he had, some years ago, provisionally assigned the value of 8·8. It had been remarked that the ethylene bonds in open-chain compounds ought to retard light differently from the double bonds in the aromatic series. This was not to be easily recognised in the refraction of A, but it was, undoubtedly, the case in the dispersion. Such considerations must have much weight in the discussion of the structure of carbon compounds exhibiting special properties.

Dr. Perkin said, in reference to Dr. Armstrong's remarks on the very high values obtained for the refractive power of the carbonyl compounds of nickel and iron, it must be remembered that these compounds were examined in the pure condition, whereas all other determinations of the refractive power of nickel and iron were made with dissolved salts and do not necessarily give true values for these metals. In the case of zinc compounds, he had found that the value of this metal in zinc ethyl was 15·9, whereas solutions of zinc salts gave only 9·8. Therefore it was not safe to infer that in the carbonyl compounds nickel and iron had the values they apparently possessed in salts. Through the kindness of Mr. Mond, he had had the opportunity of measuring the magnetic rotation of the nickel and iron carbonyl compounds, and had found that they gave very high rotations; but at present no other compounds of these metals had been examined.

As to the values given for the refraction of carbon and hydrogen being perfectly constant, even in saturated compounds this appears to be doubtful. Taking the case of ethylene oxide, they must be somewhat lower than usually given, and, in some of the amines, they appear to be higher; this is seen on comparing primary and tertiary amines, the refraction, but more especially the dispersion, increasing as we pass from the former to the latter. In the aromatic series this is very evident. Aniline itself has an abnormally high value, but, as methyl is introduced into this compound, the refraction increases with each methyl introduced much more than the change of composition requires, the increase for the first methyl being 8·36, and the change of dispersion no less than 1·37, and that for the second methyl 8·51, and of dispersion 1·22; whereas the calculated difference in each case is 7·6 only, and for the dispersion 0·34. Corresponding results are observed in reference to the magnetic rotation of all these compounds, though in a much more striking manner.

Dr. Armstrong had also made reference to the refractive power of two nitranilines; that these should be high is only consistent with their being derivatives of aniline. As to whether the difference of position of the NO_2 group would influence the refractive power of these substances in any marked degree, the data we have would be against such an assumption. Dr. Gladstone had measured several series of ortho-, meta- and para-compounds at his request, and had found them to give nearly identical results.

Mr. Mond drew attention to the very different values deducible for nickel, the atomic refraction calculated from Kundt's observations with the metal being 6·12, while that calculated from the oxide is 9·82 (*cf.* Mond and Nasini, *Zeit. phys. Chem.*, **8**, 150).

Ethereal Salts of Glyceric Acid.

Inactive.

Ethereal salt.	Density, 15°/15°.	Difference.	Boiling point.
Methyl	1·2814	0·0905	119—120° (14 mm.).
Ethyl	1·1909	0·0456	120—121° (14 mm.).
Propyl (normal)	1·1453	—	126—127° (14 mm.).
Isobutyl	1·1024		128—130° (13 mm.).

Active.

Ethereal salt.	Density, 15°/15°.	Difference.	Observed rotation in 198·4 mm. tube, α.	Specific rotation, $[\alpha]_D$.	Molecular rotation. $\frac{M.[\alpha]_D}{100}$.	Deduced specific rotation of glyceric acid ($C_3H_6O_4$), $[\alpha]_D$.	Boiling point.
M	1·2798	0·0877	−12·2°	− 4·80°	− 5·76°	− 5·43°	120° (13 mm.)
	1·1921		−21·7	− 9·18	−12·30	−11·60	—
rmal)	1·1448	0·0473	−29·4	−12·94	−19·15	−18·07	—
1	1·1303	0·0293	−26·5	−11·82	−17·49	−16·50	114—116° (13 mm.).
b ormal)	1·1155	0·0252	−24·4	−11·02	−17·85	−16·84	131—139° (14 mm.).
Isobutyl	1·1051		−31·2	−14·23	−23·05	−21·75	—
Butyl (secondary)	1·1052		−23·2	−10·58	−17·14	−16·17	123—126° (13·5 mm.).

*126. "The ethereal salts of glyceric acid, active and inactive." By Percy Frankland, Ph.D., B.Sc., F.R.S., and John MacGregor, M.A.

The following table contains the names of the glycerates, inactive and lævorotatory, which the authors have prepared, together with their densities, observed specific and molecular rotations, as well as the specific rotation of glyceric acid as deduced from the rotations of the several salts.

The method of preparation adopted for the methylic, ethylic, normal propylic and normal butylic glycerates consisted in heating glyceric acid (either inactive or active) with an excess of the particular alcohol in a sealed tube at about 180° C., and then fractioning the resulting products by distillation under greatly reduced pressure. In the case of the secondary alcohols, this method yielded an unsatisfactory result, and consequently the isopropylic and secondary butylic salts were prepared by saturating a mixture of glyceric acid and the alcohol in question with hydrogen chloride gas, and then fractioning under reduced pressure. This method was also adopted in the case of isobutylic glycerate, although this compound could also, doubtless, have been satisfactorily prepared by the sealed tube method. It was found that the facility of etherification was much greater in the case of the primary than in that of the secondary alcohols, whilst in the case of the tertiary butyl alcohol (the only tertiary alcohol experimented with) it was not found possible to obtain an ethereal salt.

In preparing the isopropylic and secondary butylic salts, a considerable quantity of a white substance was formed which was found to be an anhydride of glyceric acid, whilst in the attempt to prepare the tertiary butylic salts, this anhydride appeared to be the sole product.

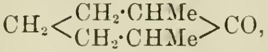
The active ethylic glycerate was prepared by both the sealed tube and hydrogen chloride methods, and the resulting products were found to have the same rotatory power, thus showing that the activity is in no way impaired by the high temperature (180° C.) employed in the sealed tube method.

Attention is directed to the relationship between the molecular rotations of the several glyceric ethereal salts experimented with. This rotation increases almost quite regularly from methylic to ethylic, to normal propylic glycerate. Isopropylic glycerate has a somewhat lower rotation than the normal propylic compound, but the isobutylic glycerate lies much more nearly on the "main line" of molecular rotatory increase than either the normal or secondary butylic compounds, the [illegible] of which correspond closely with that of the isopro[illegible] It is pointed out that the addition of CH_2 to the al[illegible]ases the molecular rotation by 6·54 in the case of methy[illegible]ylic, and of 6·85 in the case of the ethylic and normal propylic glycerates, whilst the increase is only 5·56 in the case of the ispropylic and isobutylic glycerates. These values for CH_2 are very similar to those which can be deduced in the case of ethereal salts of tartaric acid, in which, also, the rotatory value of CH_2 is less in the case of the isothan of the normal compounds.

In reviewing the rotatory power of these active glyceric ethereal salts in relation to the recently advanced theories of Guye and of Crum Brown, they are of opinion that, although in the first three terms of the series, the increase in rotation follows the increase in the weighting of one of the groups attached to the asymmetric carbon atom, yet that by a consideration of the rotatory powers of the higher terms, as well as by a comparison of the rotations of ethylic glycerate and ethylic lactate (the only active lactic ethereal salt hitherto prepared), it is obvious that the molecular rotation is affected by the qualitative nature of the groups as well as by the relative magnitude of their masses.

127. "Formation of the ketone 2:6-dimethyl-1-ketohexaphane from dimethylpimelic acid." By F. Stanley Kipping, Ph.D., D.Sc.

In a recent paper by the author and Mackenzie (*C.S. Trans.*, 1891, 569), it was stated that "when dimethylpimelic acid is heated with phosphoric anhydride at a moderately high temperature, it yields an oil having a strong turpentine-like odour; this reaction will be further investigated by one of us."

Although, on continuing the experiments, only a very small quantity of the oil was obtained in the manner indicated, owing to the formation of resinous products, the investigation was not relinquished as it seemed probable that the product would prove to be a dimethylketohexamethylene (2:6-dimethyl-1-ketohexaphane, *cf.* these Proceedings, 1892)  $CH_2<\begin{matrix}CH_2\cdot CHMe\\CH_2\cdot CHMe\end{matrix}>CO$, the formation of which in this way would be of considerable interest, not only on account of the nature of the product, but also as showing that dicarboxylic acids are capable of undergoing a change similar to that already studied in the case of the fatty acids (Trans., 1890, 532, 980).

Ultimately, by distilling the calcium salt of dimethylpimelic acid with soda lime under reduced pressure, an oil was obtained which, after agitation with soda solution, was distilled, and the portion boiling at about 180° collected separately; this fraction contained a *ketone* of the composition $C_8H_{14}O$ (found, $C = 76·5$, $H = 11·1$ per cent.; calculated, $C = 76·2$, $H = 11·1$ per cent.), capable of interacting with hydroxylamine, forming a *hydroxime* of the composition $C_8H_{14}\colon NOH$, crystallising from light petroleum in colourless prisms melting at about 112°; the hydroxime had an odour very similar to that of camphor hydroxime.

The ketone is, in all probability, a dimethylketohexamethylene; it has a peppermint-like odour, which seems to be characteristic of the cyclic ketones of this class, ketopentamethylene (Wislicenus and Hentschel), methylketopentamethylene (Semmler, (*Ber.*, **25**, 3517) and suberone, which is probably a methylketohexamethylene (compare Kipping and Perkin, Trans., 1891, 217), being all described as having this particular odour.

The publication of this note at present time seems to be desirable in view of the fact that in the last number of the *Berichte* (p. 231) von Baeyer has described a ketone, obtained by the distillation of calcium pimelate with soda lime, which is doubtless a homologue of the compound prepared by the author. The investigation is being continued.

128. "Note on the interactions of alkali-metal haloids and lead haloids and of alkali-metal haloids and bismuth haloids." By Eleanor Field, Assistant-Demonstrator in Chemistry, Newnham College, Cambridge.

By boiling potassium or ammonium iodide with lead iodide, chloride, bromide or fluoride and water in the ratio of 30 parts of the former to 1 part of the lead compound to 75 parts of water, pale yellow, needle-like crystals were obtained, having the composition $3PbI_2{\cdot}4KI$ or $3PbI_2{\cdot}4NH_4I$.

By boiling potassium or ammonium chloride, or bromide, with lead iodide and water in the ratio of 6 parts of the former to 1 part of the lead compound to 50 parts of water, lead iodochloride, $PbICl$, was obtained.

By boiling potassium or ammonium iodide with lead chloride and water, in the ratio of 1 part alkali of the former to 5 parts lead chloride to 250 parts water, iodochlorides of lead of the composition $PbI_2{\cdot}3PbCl_2$ and $PbI_2{\cdot}5PbCl_2$ were obtained; when lead bromide was used in place of lead iodide, the product was an iodobromide of lead, $PbI_2{\cdot}2PbBr_2$.

These results show that when a large excess of potassium or ammonium iodide is used, the whole of the lead haloid is transformed into iodide, if the lead compound was not iodide to start with, and that the lead iodide thus formed combines with the potassium or ammonium iodide to form a double salt; but that if less alkali-metal haloid be used in proportion to the amount of lead haloid employed, the product contains the halogen of the two haloids, and it is free from alkali-metal. The composition of the products of the interaction depends more on the relative quantities of the interacting haloids than on the nature of the metals and the halogens of the salts employed.

The results obtained by the interactions of alkali-metal and bismuth haloids differed from those obtained with lead haloids. The compound $BiBrCl_4K_2$ was obtained by dissolving bismuth chloride in solution of potassium bromide used in the ratio $BiCl_3$: KBr. The compound $BiClBr_4K_2$ was obtained when bismuth bromide was dissolved in solution of potassium chloride in the ratio $BiBr_3$: KCl. But when bismuth chloride and ammonium bromide interacted in the ratio $BiCl_3 : NH_4Br$, the same substance was obtained as when bismuth bromide interacted with ammonium chloride in the ratio of equal numbers of molecules, viz., $BiCl_3Br_3(NH_4)_3$. This compound is similar to the $SbCl_3Br_3K_3$ obtained by Atkinson (*C.S. Trans.*, 1883, p. 289) by the interaction of antimony and potassium haloids, either in the ratio $SbCl_3$: 3KBr or in the ratio $SbBr_3$: 3KCl.

These results indicate that the composition of the products of change is dependent, not only on the relative masses of the interacting haloids, but also on the nature and relative affinities of the halogens and also of the metals of the interacting haloids.

129. "An isomeric form of benzylphenylbenzylthiourea." By Augustus E. Dixon, M.D.

Phenylthiocarbimide and dibenzylamine interact, forming the compound $C_6H_5N\colon C(SH)\cdot N(C_7H_7)_2$, isomeric with the thiourea $C_7H_7N\colon C(SH)\cdot NC_6H_5\cdot C_7H_7$ (m. p. 103°), previously obtained by the author (Trans., 1891, 567) from benzylthiocarbimide and benzylaniline; it crystallises in vitreous prisms, insoluble in water, rather sparingly soluble in ether and alcohol, and melting at 145—146° (uncorr.); it is converted by the action of alcoholic ammonia at 100—110° into phenylthiourea and dibenzylamine.

130. "A new atomic diagram and periodic table of the elements." By R. M. Deeley.

After a reference to Lothar Meyer's diagram of atomic volumes and Mendeleeff's periodic table of the elements, a diagram is described in which the ordinates are "volume heats" and "volume atoms" instead of atomic volumes; a table of the elements is also given, in which the elements are arranged periodically, in accordance with their positions on the diagram.

The volume heats are obtained by multiplying specific heat by relative density, and the volume atoms by dividing relative density by atomic weight.

ADDITIONS TO THE LIBRARY.

I. *Donations.*

Grundzüge der theoretischen Chemie, von L. Meyer. Zweite Auflage. Leipzig 1893. From the Author.

Carl Wilhelm Scheele, Pharmacist and Chemist. A Brief Account of his Life and Work, 1742—1786. (Reprinted from the Pharmaceutical Journal) London 1893. From the Pharmaceutical Society.

The Year-Book of Science, edited for 1892 by T. G. Bonney. London, Paris and Melbourne 1893. From the Publishers.

II. *By Purchase.*

Mikroskopische Physiographie der Mineralien und Gesteine, von H. Rosenbusch. Band I. Stuttgart 1892.

Organische Reaktionen und Reagentien, von E. Seelig. Stuttgart 1892.

Guide pratique pour l'analyse quantitative, par C. Graebe. Genève et Paris 1892.

Berzelius und Liebig; ihre Briefe von 1831—1845, herausgegeben von J. Carrière. München und Leipzig 1892.

Handbuch der physiologisch- und pathologisch-chemischen Analyse, von F. Hoppe-Seyler. Sechste Auflage neu bearbeitet von F. Hoppe-Seyler and H. Thierfelder. Berlin 1893.

The First Principles of Chemistry, by W. Nicholson. Third edition. London 1796.

Chemistry of the Organic Dye-stuffs, by R. Nietzki. Translated, with additions, by A. Collin and W. Richardson. London 1892.

Odorographia; a Natural History of Raw Materials and Drugs used in the Perfume Industry, by J. C. Sawer. London 1892.

Quantitative Chemical Analysis by Electrolysis, by A. Classen. Translated from the 2nd German Edition by W. H. Herrick. New York 1888.

Manual of Bacteriology, by E. M. Crookshank. Third Edition. London 1890.

HOFMANN MEMORIAL LECTURE.

An extra meeting of the Society will be held on Friday, May 5th, 1893, the anniversary of the death of A. W. von Hofmann, when addresses will be delivered by the Right Hon. Lord Playfair, K.C.B., F.R.S., V.P.C.S.; Sir F. A. Abel, C.B., F.R.S., V.P.C.S.; Dr. W. H. Perkin, F.R.S., V.P.C.S.

At the next meeting, on March 16th, the following papers will be read :—

"The limits of accuracy of gold-bullion assay and the losses of gold incidental to it. The volatilisation of gold." By T. K. Rose.

"The boiling point of nitrous oxide at atmospheric pressure and the melting point of solid nitrous oxide." By Professor Ramsay.

"The isomerism of the paraffinoid aldoximes." By Professor Dunstan and T. S. Dymond.

"The hydroxime of formic aldehyde." By Professor Dunstan and Dr. Bossi.

"The properties of α-benzaldoxime." By Professor Dunstan and C. M. Luxmoore, B.Sc.

Annual General Meeting, March 27th, at 8 p.m.

HARRISON AND SONS, PRINTERS IN ORDINARY TO HER MAJESTY, ST. MARTIN'S LANE.

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PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

No. 122. Session 1892–93.

March 16th, 1893. Dr. W. H. Perkin, F.R.S., Vice-President, in the Chair.

Messrs. Edgar E. Horvill and Edward Brooke were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Ralph Edward Brown, Perranporth, Truro, Cornwall; William Robert Burnett, Wiesbaden, Rollupitiga Road, Colombo, Ceylon; Joshua Buchanan, 63, West Cumberland Street, Glasgow; Robert Cecil T. Evans, Swan's Nest, Stratford-on-Avon; Sorabji Manekji Kaka, M.R.C.S., Karachi, Sind, India; Raffaello Nasini, Padua; John Wilkinson, Gas Works, Drighlington, Yorks.

Of the following papers those marked * were read:—

*131. "The limits of accuracy of gold bullion assaying, and the losses of gold incidental to it." By T. K. Rose.

Some of the causes of the errors in the assay of gold bullion by the ordinary method are referred to, and it is shown that—

1. A higher degree of accuracy is attained if the weighings be made with the precautions recommended by Kohlrausch and others on a balance indicating differences of 0·01 per 1000 ($\frac{1}{2}$ gram), instead of 0·05 per 1000, which is the smallest difference shown on ordinary assay balances.

2. Differences either in the amount of copper present to the extent of only 16 parts per 1000 of alloy, or in the amount of silver added to the extent of 3 per cent., produce alterations in the "surcharge" of about 0·05 and 0·1 per 1000 respectively: the "surcharge" being the

difference in weight between the gold existent in the assay piece originally taken and the cornet finally obtained; it is the algebraical sum of the gold lost and the silver remaining undissolved by the acids. The reduction in the surcharge due to the presence of antimony, zinc, tellurium, iron or nickel is also given.

It therefore follows that, in order to ensure accuracy, check assays must be made on alloys of the same composition as those under examination.

3. The want of uniformity of temperature ordinarily prevailing in the muffle furnace during cupellation causes variations in the surcharge. The temperatures of the different parts of a muffle at the Royal Mint were taken during cupellation by a thermoelectric pyrometer—consisting of a platinum and rhodioplatinum couple—on three occasions, from which it appears that the mean temperature of the muffle was 1063·7°. At this temperature, a rise of about 5° is found to be accompanied by a reduction in the surcharge of about 0·01 per 1000.

If attention be paid to these points, the gold in bullion of a high degree of purity can be determined within a range of ±0·02 per 1000, the limits of accuracy having been previously considered to be ±0·10 per 1000. This extreme degree of accuracy is only possible if the check gold be pure.

In the second part of the paper, the losses of gold in bullion assaying are estimated. They are due to (1) absorption by the cupel; (2) volatilisation in the muffle; (3) dissolution in the parting acid.

The results of a number of assays are given, the gold having been in each case recovered from the cupels and acids, and, after the gold so recovered has been allowed for, the loss by volatilisation is estimated by difference. The losses, in parts per 1000, observed in the assay of standard gold (916·6 fine) were—

	A.	B.	C.
In cupel	0·513	0·36	0·51
,, 1st acid.....	?	0·01	0·03
,, 2nd ,, ...	0·012	0·02	0·04
Volatilised	0·075	0·05	0·06
Total loss ..	0·60	0·44	0·64

A and B are means of four, and C a mean of three, determinations. Other results are also given.

The determination of the amount of gold volatilised is only approximate, as the result obtained represents the algebraical sum of the errors in several estimations added to the true amount. However, it probably usually lies between 0·05 and 0·1 per 1000.

*132. "The volatilisation of gold." By T. K. Rose.

The loss of gold involved in the fusion of the pure metal and its alloys was investigated by subjecting small test pieces of from 0·5 to 2 grams in weight to a high temperature under varying conditions on bone-ash cupels placed in a muffle. The work may be considered to be a continuation of the researches of James Napier (*J. Chem. Soc.*, **10**, 229; **11**, 171). The temperatures varied from 1045° to 1300°, and were measured by either a platinum and rhodioplatinum couple or the optical pyrometer devised by M. le Chatelier. The losses of gold could not be measured by the alteration of the mass of the test pieces in the muffle owing to absorption of gases, which sensibly augment the weight of the gold buttons. The true loss was found by assaying the buttons after fusion.

A considerable number of results are quoted. The chief points of interest to which attention is drawn are that:—

1. An increase in the loss of gold takes place when the temperature is high, pure gold losing four times as much at 1245° as at 1090°.

2. A large amount of gold is volatilised in an atmosphere mainly consisting of carbonic oxide, while a small amount is lost in coal gas.

3. A comparatively small amount of gold is carried away by the more volatile metals, copper appearing to exert an exceptional action; metals which are easily volatilised do not appear to be completely driven off by the highest temperatures attained in the experiments.

4. A large proportion of gold is lost in the case of alloys which form flat buttons on the cupel, and, conversely, a small proportion is lost from spherical ones, although the surface actually exposed is greater in the latter case than in the former. A current of air or gas passing over the buttons does not seem to increase the loss, provided the surface of the molten metal remain at rest. These results point to the conclusion that the conditions which lower the surface tension of the gold button simultaneously raise the vapour pressure of the gold.

Discussion.

Professor Roberts-Austen said that, prior to the last few weeks, he should certainly have considered that the accuracy of an assay of gold was comprised within a range of ±2/10,000. Mr. Rose had, however, tracked the errors to their respective sources, and had shown that a still higher degree of accuracy can be attained in ordinary work. It was not a little remarkable that although Princep (one of the best Assay Masters who ever held that important office) had clearly indicated in 1827 the importance of knowing the variations of temperature in an assay muffle, no one had attacked the problem until Mr. Rose took it in hand. Although questions connected with assaying did not often come before the Society, they were matters to which the fathers of chemistry had given much attention. He might remind the Society that, apart from their scientific interest, these minute questions connected with assaying assumed considerable industrial importance. During his connection with the Mint, extending over more than 20 years, he had been responsible for the standard pureness of more than 600 tons of gold, the value of which was over 80 millions sterling. As regards the number of assays made, he and his two colleagues, the Assistant Assayers, had made in the past year no fewer than 30,000 assays of gold, and they had every reason to believe that their average accuracy was 1/10,000th part.

*133. "Note on the boiling point of nitrous oxide at atmospheric pressure, and on the melting point of solid nitrous oxide." By William Ramsay, F.R.S., and John Shields, Ph.D., B.Sc.

The boiling point of the liquid nitrous oxide was found by means of a constant volume thermometer filled with hydrogen to be $-89{\cdot}8°$; and the melting point of the solid to be $-102{\cdot}3°$. The method adopted is one in which the errors due to the gas in the stem of the thermometer not being at the same temperature as that in the bulb and to the alteration of the capacity of the bulb by change of temperature are eliminated.

*134. "The isomerism of the paraffinic aldoximes." By Wyndham R. Dunstan and T. S. Dymond.

Several attempts have been made during recent years to obtain evidence of an isomerism in the series of paraffinic aldoximes similar to that which has been observed and studied in a number of the corresponding benzenoid derivatives. These attempts have so far been unsuccessful, and, in fact, it has been concluded from the recent experiments of Dollfus (*Ber.*, 1892, 1908) that paraffinic aldoximes exist only in one form. The fact that the paraffinic aldoximes were, until recently, known only in the liquid condition has, however, made such enquiries difficult if not inconclusive. The problem has assumed a new aspect since the authors' discovery that acetaldoxime could be crystallised, and that when heated for some time above their melting point (m. p. 46·5°) the crystals gradually undergo isomeric change into a modification which is liquid at the ordinary temperature, but which, on cooling, slowly changes back again into the crystalline form. The physical differences between the two isomerides are for the most part very slight, there being but small differences in their relative densities and magnetic rotations. Further experiments have been made in order to compare these two modifications with the two isomeric benzaldoximes discovered by Beckmann, and, if possible, to determine the nature of the isomerism. Chemical experiments with the two modifications of acetaldoxime are difficult to carry out, owing to their instability and especially to the circumstance that the liquid modification cannot be obtained free from its isomeride.

When acted on by acetic anhydride neither modification furnishes any appreciable quanlity of acetonitrile, except at temperatures near 100°. By working under conditions whereby the occurrence of isomeric change is minimised, the crystalline acetaldoxime is converted by acetic anhydride into a liquid acetyl derivative which is so unstable that it cannot be isolated in the pure state; it decomposes when distilled, even under reduced pressure. It is hydrolysed by water as well as by dilute alkalis, yielding acetic acid and the aldoxime. The liquid acetaldoxime also furnishes an acetyl derivative, which apparently is identical with that obtained from the crystalline isomeride. In some cases the action of acetic anhydride on both modifications has led to the production of a small quantity of *hydroxyacetylaldoxime* (*diacethydroxamic acid*), $CH_3C(OH)NO(COCH_3)$, a solid crystalline substance melting at 87·5°.

Both modifications of acetaldoxime are converted by hydrogen chloride into the same crystalline hydrochloride, ($CH_3CH\colon N{\cdot}OH,HCl$), a very hygroscopic substance.

By the action of phosphoric chloride at a low temperature on an ethereal solution of the crystalline acetaldoxime a product is obtained which on hydrolysis gives ammonia and acetic acid as well as methylamine and formic acid. A determination of the quantity that is formed of each of these substances has shown that 90 per cent. of the aldoxime is converted into ammonia and acetic acid, and the remainder into methylamine and formic acid. When acted on by phosphoric chloride at a higher temperature, the liquid acetaldoxime is converted into a product which on hydrolysis furnishes the same products as the crystalline modification, and in almost the same proportion.

On the other hand, the two isomerides afford only ammonia and acetic acid when acted on by phosphorous chloride.

Propionaldoxime, $C_2H_5{\cdot}CH\colon NOH$, has hitherto been known only as a liquid (b. p. 132°); it may, however, be crystallised by cooling it to about −12°, and thoroughly stirring the liquid. The crystals closely resemble those of acetaldoxime in appearance; they melt at 22°, that is, 24·5° lower than the acetic compound. If it be melted and the resulting liquid be heated for some time, propionaldoxime gradually undergoes an isomeric change similar to that suffered by acetaldoxime, being converted into a liquid which cannot be made to crystallise by any means unless it be cooled below −10°, when crystals of the other modification separate, and by degrees entire reconversion into this form takes place.

There is only a slight difference in the relative densities of the two modifications. Phosphoric chloride acts on a well-cooled, ethereal solution of the crystalline propionaldoxime, and when the mixture is poured into water ammonia and propionic acid are produced as well as ethylamine and formic acid. About 94 per cent. of the aldoxime is converted into ammonia and propionic acid, and about 6 per cent. into ethylamine and formic acid.

When acted on by phosphorous chloride, however, it affords only ammonia and propionic acid.

Isobutyric aldoxime is a liquid (b. p. 139·5°) which does not crystallise even when cooled to −80°. When acted on by phosphoric chloride, about 60 per cent. of the aldoxime is converted into ammonia and isobutyric acid, and about 40 per cent. into isopropylamine and formic acid.

It would appear from these results that further study is requisite to establish criteria of stereochemical isomerism in the case of these oximes. It would seem that the action of phosphoric chloride in particular is attended with structural isomeric change, and that the production by Beckmann's method of two acids and two amines cannot be regarded as evidence of the existence in the compound of two stereochemical forms of the original oxime, as has been suggested by Hantzsch, in the case of certain ketoximes.

It has, therefore, been determined to submit the two isomeric benzaldoximes to a more minute examination than they have hitherto received; these aldoximes being selected, rather than any of the paraffinoid compounds, on account of their greater stability. Progress has already been made with this work.

135. "The mineral waters of Askern, in Yorkshire." By C. H. Bothamley.

Although the mineral waters of Askern have a well-established reputation in the treatment of chronic rheumatism and of skin diseases, no analyses of them have been made since those of Lankester and West in or about the year 1840.

There are at present four wells or springs in the peat common on the edge of which the village of Askern stands, and to each of these is attached a pump room and a suite of baths. The author has examined samples of the waters collected at intervals extending over a period of nearly two years. They are surface or shallow spring waters, and are mainly solutions of calcium and magnesium carbonates and sulphates, containing a large quantity of dissolved peaty matter and a considerable amount of hydrogen sulphide; minute traces of iodine and lithium, but neither bromine nor potassium, were detected. The approximate composition of the four waters, in grams per litre, is as follows:—

	Mother Close Well.	Terrace Baths.	Charity Baths.	Manor Baths.
Calcium carbonate	0·8417	0·8232	0·6825	0·6698
,, silicate	0·0281	0·0262	0·0443	0·0449
,, sulphate	0·5222	0·4434	0·4938	0·5151
Magnesium sulphate	0·3874	0·4288	0·7184	0·6834
Sodium chloride	0·0346	0·0989	0·1190	0·1205
,, sulphate	0·0426	0·0220	0·0659	0·0599
Total	1·8566	1·8425	2·1239	2·0936
Hydrogen sulphide	56·7 c.c.	49·5 c.c.	34·8 c.c.	37·3 c.c.

It is pointed out that the production of the sulphuretted hydrogen is probably due to the action of an organism, although hitherto the author has failed in isolating one.

136. "Note on the distribution of acidic and alkalinic radicles in a solution containing calcium, magnesium, carbonates and sulphates; and on the composition of mineral waters." By C. H. Bothamley.

In examining the mineral waters of Askern, it was found that the precipitate formed when the "free" carbon dioxide was expelled was almost pure calcium carbonate, and contained the merest trace of magnesium, although this element was present in considerable quantity. Direct experiments show that an excess of well-washed precipitated magnesium carbonate completely precipitates calcium from a solution of calcium sulphate in the absence of "free" carbon dioxide, and that there is practically no reverse action when a solution of magnesium sulphate is placed in contact with a large excess of precipitated calcium carbonate. When solutions of calcium carbonate and magnesium sulphate are mixed together and the "free" carbon dioxide is expelled by the action of heat or by the passage of a current of hydrogen, the precipitate contains only a mere trace of magnesium. The same result is obtained when a solution of magnesium carbonate is mixed with a solution of calcium sulphate and the "free" carbon dioxide is expelled by a current of hydrogen.

The existing thermochemical data afford no explanation of these results.

The author concludes that if we put aside the question of ionic dissociation in solution, and represent mineral waters and similar solutions of calcium, magnesium and the carbonic and sulphuric acid radicles as containing salts as such, the sulphuric radicle must be regarded as combining by preference with magnesium and not with calcium, as is generally supposod. In the case of the Askern waters this view is supported by their therapeutic action.

137. "A magnesium compound of diphenyl." By W. R. Hodgkinson.

The energetic manner in which ammonia gas and some ammonium salts are decomposed by magnesium suggested that perhaps benzenoid amines, and especially anilids, might give metallic derivatives. Magnesium, however, is entirely without action on dry aniline, toluidine and other similar alkaloids; and form- and acetanilid and even phthalanil are unaffected when passed over the metal heated to about 400°.

When phenylhydrazine is warmed with magnesium, either in the form of filings, ribbon, or wire, action begins at about 150°; using filings, if not carefully controlled, the action becomes almost explosive, the temperature attained being frequently sufficient to inflame the products. The products which volatilise during the process are aniline, benzene, ammonia and nitrogen; a compound containing the metal being left in the retort.

The magnesium compound is a solid, nearly white substance; it does not volatilise, but on heating the contents of the retort in which the operation has been conducted to nearly a red heat, an oil distils over from which a small quantity of diphenyl may be isolated. On admitting air into the retort before it is quite cold, the substance turns brown, and in most instances inflames. Water has a similar effect on the hot substance.

Boiling benzene, and especially cymene, dissolve a metallic compound which is deposited partly on cooling and partly on evaporating off the solvent in a vacuum as a brown, amorphous powder; this takes fire on very gently heating it in air, magnesium oxide and much charcoal being left.

As yet the analyses of different preparations of this substance have not been very satisfactory. It certainly does not contain much, if any, nitrogen as an essential element, the highest percentage found being $1\frac{1}{4}$; this appears to be derived from some nitrogen compound formed by a secondary action and not from a magnesium phenylhydrazine or magnesium aniline.

The unmistakable production of diphenyl on heating the magnesium compound is suggestive of the presence of magnesium diphenyl as one of the products.

The author wishes to reserve the further investigation of the interaction.

138. "Note on acetanhydrocitric acid." By Felix Klingemann.

The author points out that the acetylanhydrocitric acid described by Easterfield and Sell (Trans., 1892, 1003) had been previously prepared and studied by himself (*Berichte*, 1889, 983); he adversely criticises several of their statements, and quotes analyses of the silver salts of citrodianilic and citro-*p*-toluidic acids, proving that both are mon-acids.

139. "The dissolution of gold in a solution of potassium cyanide." By R. C. Maclaurin, B.Sc.

The study of the conditions contributory to the dissolution of gold in solutions of potassium cyanide is become of importance, owing to the recent use of this agent in extracting gold from poor ores. The nature of the changes is disputed: Elsner originally expressed the interaction by the equation $4Au + 8KCN + O_2 + 2OH_2 = 4AuCN \cdot KCN + 4KOH$, but McArthur, in a recent paper, has called in question the necessity of oxygen being present. It is a remarkable fact in connection with the process that the rate of dissolution of the gold decreases as the concentration of the cyanide solution increases.

It is shown that dissolution of the metal is conditioned by oxygen, and that the amounts of oxygen absorbed and of gold dissolved are in the ratio $O : 2Au$. Furthermore, it is shown that the rate of dissolution varies with the strength of the solution, and that it passes through a maximum in passing from dilute to concentrated solution; this variation is traced to a decrease in solubility of oxygen in solutions of potassium cyanide as the concentration increases.

March 27th, 1893. Annual General Meeting. Professor Crum Brown, F.R.S., President, in the Chair.

The President delivered an address, of which the following is an abstract:—

The numerical position of the Society is as follows:—

Number of Fellows, March, 1892		1825
Since elected who have paid admission fees		128
		1953
Removed on account of non-payment of subscriptions	20	
Withdrawn	18	
Deceased	20	
		58
Present number of Fellows		1895
Foreign Members (1892)	30	
Since elected	5	
Present number of Foreign Members		35

20 Fellows have died within the year:—G. S. Bowler, H. N. Draper, John Hooker, A. W. von Hofmann, F. C. Hills, W. E. Ivey, Hodgson Jones, Dr. G. D. Longstaff, W. H. Michael, G. H. Makins, J. S. Merry, Dr. T. H. Rowney, John S. Sieber, Professor C. Schorlemmer, A. Norman Tate, Thomas Taylor, Dr. Thos. Walton, J. Septibo Ward, Dr. J. Forbes Watson, Mattieu Williams.

18 Fellows have withdrawn:—Thomas Akitt, Dr. James Bell, Edward Dillon, J. V. Elsden, J. C. Husband, W. E. Halse, Farmer Hall, E. T. Kensington, Lawrence Levy, Chas. O'Neill, Dr. G. S. W. Ogg, Magnus Ohren, G. A. Parkinson, H. F. Pasley, Edward Purser, A. H. Tapp, E. W. Wiltshire, Dr. George Wilson.

The names of 20 Fellows have been removed from the Register:—James Anderson, Dr. J. B. Battershall, Frank Calder, G. E. R. Ellis, D. R. S. Galbraith, G. W. S. Howson, J. J. Hickey, A. C. M. Ingram, George Lloyd, H. Oliver Mintz, J. W. O'Connor, C. T. Rhodes, E. Reckett, W. Symons, H. L. Schubert, H. L. Sulman, Stanley Southam, T. B. Tyson, Dr. F. W. Traphagen, M. Whitley Williams.

Professors Emil Fischer, Carl Graebe, Adolph Lieben, Hugo Schiff and Th. Schloesing have been elected Foreign Members.

No fewer than 139 communications are recorded in the Proceedings, this being the largest number yet contributed to the Society in a single session.

The 1892 volume of the Transactions contains 90 papers, occupying 1096 pages, while the Abstracts occupy 1536 pages.

From the commencement of this year, the Abstracts have been so paged that it will be possible to bind them in two sections, the one section to include all papers on organic chemistry, the other the remaining branches; this arrangement has been adopted by the Council in the belief that it will tend to promote continuity and facilitate reference.

The Council have resolved that a subject index of the original communications published in the Society's Journal during the years 1873–92 inclusive shall be published. It is suggested that this shall be a true index and not a mere recital of titles; the precise form it shall take is, therefore, under consideration.

Two "Memorial Lectures" have been delivered during the year, commemorating the work of two deceased Foreign Members, Hermann Kopp and Jean Servais Stas: that on Stas was prepared by Professor Mallet, and that on Kopp by the Treasurer, Professor Thorpe; the Society and chemists generally will undoubtedly feel that they are much indebted to both of these two gentlemen when the two memoirs are placed in their hands. In the first of these lectures, Professor Mallet, besides referring to Stas's work, has carefully considered its bearings, and has indicated directions in which enquiries may, with advantage, be now carried on; the example that he has set will undoubtedly be of great service in the preparation of similar memoirs. The Council have resolved to print an extra number of copies of such lectures, and when in possession of a sufficient number to form a volume, to issue them in a separate form.

Among the Fellows deceased during the year there are two whose services to the Society have been of an *altogether* special character—Professor von Hofmann and Dr. G. B. Longstaff; special resolutions of condolence have been passed by the Council and communicated to their families. Von Hofmann's work will be considered in the coming Hofmann Memorial Lecture. In Dr. Longstaff the Society loses one of its original Fellows, of whom now very few remain. He was a very active member of the Society in early days, and within recent years his munificence secured the establishment of the Research Fund; owing to his stipulation that a medal should be awarded at least triennially to a Fellow of the Society in recognition of the value of his researches, Dr. Longstaff's name will ever remain associated with the Society and with chemical science, as the Council determined that the medal should be known as the Longstaff Medal.

Towards the close of the year, an address, offering the Society's congratulations on the occasion of the celebration of its twenty-fifth anniversary, was forwarded to the Deutsche chemische Gesellschaft in Berlin.

An address from the Society was presented to M. Pasteur on the occasion of his 70th birthday.

Communications were addressed by the Foreign Secretary to the University of Padua on the occasion of the Galileo celebration and to the Committee in Stockholm charged with the erection of a memorial to Scheele in response to invitations to the Society to take part in these proceedings.

The Council are indebted to Mr. E. H. Wollaston for the presentation of a valuable proof engraving of a portrait of Wollaston.

Very considerable additions have been made to the library during the year.

The subject of the admission of women as Fellows, which has been several times discussed by the Council, has been again brought under consideration during the year, but without any resolution being arrived at to propose an alteration in the Bye-laws: it appeared to be generally felt that, although there is no objection in principle to the admission of women as Fellows, the case in their favour is not clearly established by any considerable number of applications.

During the long vacation the meeting room was entirely reconstructed, with the result that a very considerable air space has been gained, tending to the better ventilation of the room; additional accommodation both in sitting space and in entrances and exits has also been secured; and provision has been made for the entrance of fresh air into, and for the removal of vitiated air from, the room. The electric light has been substituted for gas in all the rooms. The apartments were redecorated throughout.

The structural alterations were planned and their execution superintended by Mr. Martin L. Saunders, and the alterations and redecoration of the rooms have been carried out by Messrs. Colls and Sons. The installation of the electric lighting was planned by Professor Ayrton, to whom the Society is under great obligation for the amount of time and thought he has expended on the work. The business of wiring the building and fixing the fittings for the electric light was entrusted to Messrs. Spagnoletti and Crookes, and the brackets, pendants, &c., were supplied by Messrs. Faraday and Sons.

	£	*s.*	*d.*
The cost of the structural alterations (including architect's fee) have been	1113	14	10
The electric light installation having cost....	289	0	6
	£1402	15	4

It is a matter of congratulation to the Society that the Treasurer has been able to pay these large extra expenses, and at the same time to carry forward the necessary working balance, without touching the Society's funded property.

In the latter part of his address the President discusses the history of the phlogistic theory, and its gradual displacement by more modern views.

Dr. Armstrong proposed a vote of thanks to the President, coupled with the request that he allow his address to be printed. In the course of his remarks, he said that during the past two years, for the first time in the history of the Society, the President had been a Fellow from beyond the Border—a fact of much importance, as proving that they were in no sense a mere metropolitan society, and that they both desired to secure, and were, indeed, successful in securing, the cooperation of British chemists generally. Dr. Gladstone seconded the motion, which was carried by acclamation. The President having thanked the meeting,

Mr. Holland Crompton, the Senior Auditor, in the absence of the Treasurer abroad, gave an account of the balance sheet duly audited by Mr. Dymond, Dr. Lawson and himself. Professor Thomson subsequently contrasted the chief items of expenditure during this and the previous year. The receipts by admission fees and subscriptions had been £3771 11*s.* 4*d.* as against £3545 in the previous year; and £424 15*s.* 3*d.* had been realised by the sale of the Journal, instead of only £408 7*s.* 4*d.* The Journal had cost £2745 7*s.* 4*d.* instead of £2798 15*s.* 10*d*; £327 1*s.* 1*d.* had been expended on the library; the alterations had been effected at a cost of £1402 15*s.* 4*d*; the total expenditure being £5287 1*s.*: so that the ordinary expenditure had been £3884 5*s.* 8*d.* as against £3989 1*s.* 6*d.* in the previous year. Grants amounting to £200 had been made from the Research Fund.

A vote of thanks to the Treasurer was proposed by Dr. Russell, who dwelt with satisfaction on the fact that it had been possible to meet the expenses of the alterations from the surplus income of this and the previous year without touching the Society's funded property. The vote, having been seconded by Professor Ramsay, was carried by acclamation.

Mr. Crookes proposed and Mr. Pickering seconded a vote of thanks to the Auditors; the motion having been adopted, Mr. Crompton replied.

A vote of thanks to the Officers and Council was then proposed by Mr. J. Newlands and seconded by Mr. Cassal; Professor Thomson replied.

Dr. J. Voelcker moved and Mr. Spiller seconded a vote of thanks to the Editor, Sub-Editor, Abstractors and Librarian. Mr. Groves and Dr. Thorne replied.

Mr. W. Foster and Mr. Tutton having been appointed Scrutators, a ballot was taken, and the following were declared elected.

President: H. E. Armstrong, Ph.D., F.R.S.

Vice-Presidents who have filled the office of President: Sir F. A. Abel, K.C.B., D.C.L., F.R.S.; Dr. A. Crum Brown, F.R.S.; W. Crookes, F.R.S.; E. Frankland, D.C.L., F.R.S.; J. H. Gilbert, Ph.D., F.R.S.; J. H. Gladstone, Ph.D., F.R.S.; H. Müller, Ph.D., F.R.S.; W. Odling, M.B., F.R.S.; W. H. Perkin, Ph.D., F.R.S.; Lord Playfair, Ph.D., K.C.B., F.R.S.; Sir H. E. Roscoe, LL.D., F.R.S.; W. J. Russell, Ph.D., F.R.S.; A. W. Williamson, LL.D., F.R.S.

Vice-Presidents: E. Atkinson, Ph.D.; A. Vernon Harcourt, F.R.S.; C. O'Sullivan, F.R.S.; John Pattinson; William Ramsay, F.R.S.; William A. Tilden, F.R.S.

Secretaries: J. Millar Thomson; Wyndham Dunstan, M.A.

Foreign Secretary: Raphael Meldola, F.R.S.

Treasurer: T. E. Thorpe, D.Sc., F.R.S.

Ordinary Members of Council: Norman Collie, Ph.D.; Charles F. Cross; Harold Dixon, F.R.S.; Bernard Dyer, D.Sc.; Lazarus Fletcher, M.A., F.R.S.; R. J. Friswell; M. M. P. Muir; F. J. M. Page; W. H. Perkin, jun., F.R.S.; W. A. Shenstone; John A. Voelcker, Ph.D.; W. P. Wynne, D.Sc.

The following additions to the bye-laws, proposed by the Council, were then submitted to the meeting and carried:—

1. In Bye-Law XI, after the words "The ordinary Scientific Meetings of the Society shall be held twice in every month, from November to June inclusive, except in the month of January, when the Society shall meet once only," to add the words "and also at Easter, when, if the Council see fit, there shall also be only one meeting in the month."
2. In Bye-Law XIII, to add the following paragraph:—

> "At all General Meetings of the Society, whether Annual or Extraordinary, no motion of a proposal to alter the bye-laws shall be considered of which due notice has not been given at least 14 days previously, either at an ordinary Scientific Meeting, or through the agency of the 'Proceedings,' or by means of a printed notice addressed to all the resident Fellows."

ADDITIONS TO THE LIBRARY.

I. *Donations.*

Traité pratique de calorimetrie chimique, par M. Berthelot. Paris 1893. From the Author.

Pharmaceutical Society of Great Britain: Chemical Papers from the Research Laboratory, edited by W. R. Dunstan. Vol. I. London 1892. From the Council, Pharm. Soc.

II. *By Purchase.*

Annales de Chimie. Série I, Tomes 61—96. Paris, 1807—1815.

Grundriss der Stereo-chemie, von Hantzsch. Breslau 1893.

Die menschlichen Nahrungs- und Genussmittel, von J. König. Dritte Auflage. Band II. Berlin 1893.

Die Weine des Herzoglich-Nassauischen Cabinetkellers: eine wissenschaftliche Studie, von C. Schmitt. Berlin 1893.

Tafel zur Ermittelung des Alcoholgehaltes von Alcohol-Wasser-Mischungen aus dem specifischen Gewicht, von K. Windisch. Berlin 1893.

HOFMANN MEMORIAL LECTURE.

An extra meeting of the Society will be held on Friday, May 5th, 1893, the anniversary of the death of A. W. von Hofmann, when addresses will be delivered by the Right Hon. Lord Playfair, K.C.B., F.R.S., V.P.C.S.; Sir F. A. Abel, K.C.B., F.R.S., V.P.C.S.; Dr. W. H. Perkin, F.R.S., V.P.C.S.

At the next meeting, on April 20th, the following papers will be read:—

"A contribution to the chemistry and physiology of foliage leaves." By Horace T. Brown, F.R.S., and G. Harris Morris, Ph.D.

"The interaction of alkali cellulose and carbon bisulphide. Cellulose thiocarbonates." By C. F. Cross, E. J. Bevan and C. Beadle.

And other papers.

CERTIFICATES OF CANDIDATES FOR ELECTION AT THE NEXT BALLOT.

N.B.—The names of those who sign from "General Knowledge" are printed in *italics.*

The following Candidates will be balloted for on 4th May, 1893 :—

Baine, Laurence Augustus,

Dipton, Lintz Green, Newcastle-on-Tyne.

Doctor of Medicine. D.P.H. (Camb.), Membre de la Société française d'Hygiène (in practice). As student under Professor Tilden, Mason College, Birmingham, and under Professor Bedson, College of Science, Newcastle (for about three years) ; specially interested in analyses of foods and beverages.

P. Phillips Bedson. Saville Shaw. J. T. Dunn.
A. Wynter Blyth. *W. H. Corfield.*

Baker, Julian L.,

Stamford, Hendham Road, Upper Tooting, S.W.

Assistant Chemist to the Beetroot-Sugar Association of London. Certificated Student of Chemistry of Finsbury Technical College, having taken up at that Institution the complete course of study for the prescribed number of years. Joint author in a paper on "Halogen Derivatives of Quinone," published in the Society's Transactions for 1892, p. 589.

Arthur R. Ling. Raphael Meldola. R. J. Friswell.
John A. R. Newlands. Henry E. Armstrong.

Bone, William A.,

Schlossberg 3, Heidelberg.

Fellow of Victoria University. Engaged in a research with Professor Victor Meyer, at Heidelberg. Three years student in Owens College. B.Sc. with 1st Class Honors in Chemistry, Vict. Univ., 1891. Research Fellow of the Owens College, 1891–92. University Fellow, 1892. Author of "The Behaviour of Ethylene on Explosion with less than its own volume of Oxygen" (*J. Chem. Soc.*, 1892, 873).

Harold B. Dixon. G. H. Bailey. Arthur Harden.
P. J. Hartog. G. I. Fowler.

Briggs, John Frederick,
c/o Messrs. Parry and Co., Madras.

Assistant Chemist at Parry's Sugar Works, Madras. Associate of the City and Guilds of London Institute. Joint author with Professor Armstrong of "The Relative Orienting Effect of Chlorine and Bromine" (*Chem. Soc. Proc.*, 1892, **108**, 40).

Henry E. Armstrong. F. Stanley Kipping.
Arthur R. Ling. W. J. Pope.
W. Palmer Wynne.

Burnham, John Charles,
179, Griffen Road, Plumstead, Kent.

Analytical Chemist. Four years student at the Owen's College, Manchester. Three years of this time devoted to Physics and Chemistry (Honours School, Victoria University). Associate of the Owens College. B.Sc. (1st Class) Victoria University. Four years Assistant Chemist (one of) at the Chemical Department of the War Department, Royal Arsenal, Woolwich, and to the "Special Committee on Explosives," President, Sir F. A. Abel, K.C.B.

F. A. Abel. Harold B. Dixon. G. H. Bailey.
W. Kellner. W. H. Deering.

Brown, Ralph Edward,
Perranporth, Truro, Cornwall.

Analytical Chemist. For three years student at the Durham College of Science, Newcastle-on-Tyne, obtaining the Associateship in Science, and passing the Science portion of the examination for the degree of Bachelor of Science of the University of Durham, obtaining Honours in Chemistry.

P. Phillips Bedson. Saville Shaw. Alfred C. Fryer.
Harold Picton. Walter T. Reid. *F. C. Garrett.*

Buchanan, Joshua,
63, West Cumberland Street, Glasgow.

Analytical and Technical Chemist. Experience—over 10 years as Analytical and Technical Chemist; 4 years Head Chemist to a Metallurgical Work. Publications—with Dr. Mills, "The Photochemical Estimation of Graded Tint" (*J. Soc. Chem. Ind.*, April, 1888), "On the Nitrate and Iodine Industries of Northern Chile" (*J. Soc. Chem. Ind.*, February, 1893).

Edmund J. Mills. A. Humboldt Sexton. James G. Hardy.
G. G. Henderson. John Ferguson.

Burnett, William Robert,

Dunleth Avenue, Coatbridge, N.B.; For the future, Wiesbaden, Rollupetiga Road, Colombo, Ceylon.

Analyst. Presently, Assistant to Mr. Cochran, City Analyst for Colombo, and Lecturer in Chemistry in Ceylon Medical College, selected as fitted to fill the post of Acting City Analyst for Colombo. Formerly, Assistant for three years in the laboratories of R. R. Tatlock and Readman, City Analysts, Glasgow.

R. R. Tatlock, Alfred H. Allen. A. Humboldt Sexton.
M. Cochran. Horatio Ballantyne. *John Clark.*
G. G. Henderson.

Cameron, James,

Nobel's Explosives Company, Ltd., Polmont Station.

Chemist. Attended Dr. Clark's lectures on Organic and Inorganic Chemistry 2 sessions, the laboratory of Wallace, Tatlock, and Clark for 2 years, and Professor Sexton's lectures at Technical College. Have acted as Chemist for 3½ years to Glasgow Gas Works, and 2 years to Nobel's Company.

John Clark. Robert R. Tatlock. George Smith.
D. Corrie. Geo. McRoberts. *J. C. Butterfield.*

Clayton, George,

School of Pharmacy, 100, Burlington Street, Manchester.

Teacher of Chemistry. A student of Organic and Inorganic Chemistry for 16 years. Member of the Pharmaceutical Society of Great Britain. For the past 9½ years has lectured on Theoretical and taught Practical Chemistry. During the last 3 years has controlled the Analytical and Practical Work of the laboratories of the Northern School of Pharmacy, of which he is Principal.

Frank Scudder. Francis Jones. Harry Grimshaw.
H. E. Roscoe. *Watson Smith.* *C. R. Alder Wright.*

Dickinson, H. W.,

Kent Place, Ulverston, Lancashire.

Iron and Steel Works Engineer. Undergraduate, Victoria University. Attendance, 2 sessions, 1886–87 and 1887–88, Chemical

Lectures, Owens College, Manchester. $3\frac{1}{2}$ years' experience with Messrs. Wm. Beardmore and Co., Parkhead Forge, Glasgow; of which $2\frac{1}{2}$ years were spent in Chemical Laboratory. Studied 3 years, evening classes, at Glasgow and West of Scotland Technical College. Hold highest certificates of South Kensington and City and Guilds of London in Chemistry and Metallurgy.

H. Lloyd Snape. A. Humboldt Sexton. James G. Hardy.
Sydney J. Harris. Edmund G. Tosh. *G. G. Henderson.*

Dixon, Harry Williamson,
258, Hunslet Road, Leeds.

Works Chemist. Eight years at Messrs. Taylor Brothers and Company's Clarence Iron and Steel Works, Leeds. Student, Chemistry, Metallurgy, &c., at Leeds School of Science and Yorkshire College. Honours Results in Practical Chemistry (Science and Art Department) and Iron and Steel (City and Guilds of London Institute) Examination.

J. Wertheimer. B. A. Burrell. Ed. Rawlins.
H. Broadbent. Herbert Eccles. A. W. Cooke.

Edwards, Thomas,
Brewery House, Rhymney.

Brewery Manager and Analyst. Assistant to Wm. McCowan, Esq., F.S.C., F.I.C., for 5 years in the brewery and laboratory of Henry Mitchell and Co., Ltd., Birmingham. Head Brewer at Rhymney Brewery for 4 years. Private study (analytical and microscopical research) for 10 years.

William McCowan. J. Cuthbert Welch.
J. Farrow Ballard. *John Attfield.*
A. Boake. *F. G. Adair Roberts.*

Evans, Robert Cecil Turle,
Swan's Nest, Stratford-on-Avon.

Five years' study at the City and Guilds Institute under Professors Meldola, Thompson, and Perry. Technical and Research Chemist to Messrs. F. Kendall and Son, Chemical Manufacturers. Gained the certificates of the Technical College, Finsbury, in the Departments of Electrical Engineering, and in Industrial and Technical Chemistry. One year as Chemist to Messrs. Kendall and Son, Chemical Manufacturers. Student of the Institute of Chemistry.

R. Meldola. E. R. Moritz. Charles E. Cassal.
Gerald T. Moody. W. J. Pope. G. F. Kendall.
C. R. Alder Wright. *B. Henry Gerrans.* *F. Stanley Kipping.*

Gardner, John Addyman,

5, Bath Place, Oxford,

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William Odling. W. W. Fisher. J. E. Marsh.
John Watts. V. H. Velcy. D. H. Nagel.

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Thomas Turner. W. W. J. Nicol. Arthur Adams.
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Assistant to Professor of Chemistry and Physics, Royal Military Academy, Woolwich. Associate and Fellow of the Institute of Chemistry by Examination, 1888. Arts Examination Soc. Apothecaries, 1880. 1st L.R.C.P., November, 1882. Formerly student of

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W. R. Eaton Hodgkinson. John M. Thomson.
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Redwood Scholar in the Research Laboratory of the Pharmaceutical Society. Formerly Bell Scholar in the School of the Pharmaceutical Society. Medallist in Chemistry and Practical Chemistry. Pereira Medallist, 1892. Passed the Major Examination of the Pharmaceutical Society, 1892.

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W. S. Squire.
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Medical Practitioner. I am an M.D. of Brussels (avec distinction). I am a Licentiate of the Royal College of Physicians (Edin.), a Licentiate of the Royal College of Surgeons (Edin.), and a Licentiate of the Faculty of Physicians and Surgeons (Glasgow), and I also hold the Diploma in Sanitary Science of Cambridge. I am the author of a book on "Lord Bacon."

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Professor of Chemistry, Colgate University. Student, Göttingen, Germany, 1880–81, 1883–84. Instructor in Chemistry, Amherst College, Amherst, Mass., 1881–83. Professor of Chemistry, Colgate University, Hamilton, N.Y., since 1884. Short articles on "Analytical Methods."

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Lecturer on Agricultural Chemistry and Agriculture to the Kent County Council and for University Extension. Studied Chemistry at University Laboratory, Oxford, at Pharmaceutical Society's Laboratory, and in private laboratories. General interest in Chemistry.

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Nasini, Raffaello,

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Professor of Chemistry.

Ludwig Mond.
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William Tate.
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Analytical Chemist. Three years Analytical Assistant and three years Teaching Assistant to Mr. Tatlock, City Analyst for Glasgow, &c. Delivered three courses of lectures on Theoretical Chemistry and Qualitative and Quantitative Analysis.

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Analytical Chemist. Analyst in the Inland Revenue Laboratory, Somerset House, since 1883. First Class Certificate in Chemistry, Royal School of Mines.

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Analyst and Consulting Chemist. Studied at University College, Cardiff, from 1884 to 1887, entering same in 1884 with an exhibition of fees. Gained prize of £10 in 1885; at close of session, 1886–87, took 4 certificates, various subjects, with 1 1st class Theoretical Chemistry, and 1 certificate and 1st prize Practical Chemistry. Passed London Matriculation, 1st Division, in 1885. Carried on practice in Newport since October, 1887, as Analyst and Consulting Chemist. Have been appointed since 1891 as Lecturer in Chemistry and Laboratory Director to Technical Schools of county of Newport.

John Parry.	R. W. Atkinson.
Claude M. Thompson.	J. William James.
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Analytical and Consulting Chemist. Chemist to City of Buffalo. Professor of Chemistry, University of Buffalo. Contributor to *Reference Handbook of Medical and Chemical Jurisprudence* (in press, by Wm. Wood and Co.). Associate Editor of the *Engineering Magazine*, N.Y. City.

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Student of Chemistry since 1889. Student at the Surgeons' Hall Laboratory, Edinburgh, for eighteen months; for two winter sessions at the Heriot-Watt College; and for a year at the Edinburgh University Laboratory. At present engaged in Organic Research Work with Professor Crum Brown.

W. H. Perkin, Jun. Robert Wallace.
Alex. Crum Brown. Hugh Marshall.
Leonard Dobbin.

Wilkinson, John,

Gasworks, Drighlington, Yorks.

Gas Engineer. 3 years' study in the Chemistry Department at the Bradford Technical College. 6 years' study and investigation in the Manufacture of Coal Gas, &c.

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PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

No. 123. Session 1893-94.

April 20th, 1893. Dr. Armstrong, President, in the Chair.

Mr. Wm. E. Wheeler was formally admitted a Fellow of the Society.

Certificates were read for the first time in favour of Messrs. Henry Bailey, 18, Lavender Sweep, London; Douglas S. P. Berringer, B.A., Malvern College, Malvern; John Henry Coste, 69, Goswell Road, E.C.; Arthur Henry Green, 176, Lloyd Street, Greenheys, Manchester; Charles Mills, Hazeldean, Fulham Park Gardens, S.W.; Alexander Orr, 109, Pitt Street, Sydney, Australia; Charles Herbert Pring, The Ferns, Longfield Road, Bristol; George Ritchie, 8, Buchanan Gardens, Mount Vernon, N.B.; Henry Thomas Sorrell, Holly Lodge, Hill, Southampton West; Sydney Whalley 38, Havelock Street, Canterbury; Thomas Whittaker, 76, Arden Terrace, Accrington.

Of the following papers those marked * were read:—

*1. "A contribution to the chemistry and physiology of foliage leaves." By Horace T. Brown, F.R.S., and G. Harris Morris, Ph.D.

The investigation relates to the occurrence, relations and physiological significance of the starch, diastase and sugars contained in foliage leaves.

The authors divide the subject into two parts; the first, dealing with the starch and diastase of leaves, is subdivided into the following sections:—(1) introduction; (2) historical; (3) the starch of the leaf, its determination and the proportion it bears to the total products of assimilation; (4) the occurrence of diastase in the leaf;

(5) the nature of the products of transformation of starch by leaf-diastase; (6) the determination of the diastatic activity of leaves; (7) the periodic variation of the diastase of leaves; (8) Can leaf-diastase act on solid starch; (9) How far is the disappearance of leaf-starch due to living protoplasm? The second part treats of the sugars of the leaf, and consists of an historical section, and one dealing with the sugars of *Tropæolum majus.* The bibliography of the subject is summarised in an appendix.

The work originated in an attempt to discover the explanation of the conditioning effect of "dry-hopping," *i.e.*, the addition to finished beer of a small amount of dry hops. This was ultimately traced to the presence in the hop-strobiles of a small, but appreciable, amount of *diastase*, sufficient to slowly hydrolyse the non-crystallisable products of starch-transformation left in the beer, and to reduce them to a condition in which they can be fermented by the yeast. In endeavouring to ascertain if this occurrence of diastase in the hop-strobile was an isolated case, or a special example of a widely distributed property of vegetable tissue, the authors were led to enquire into the first formation of starch in the chloroplasts of the foliage leaf, the mode of its dissolution and translocation in the plant and the nature of the metabolised products.

The results obtained are regarded as entirely antagonistic to the assumption made by Sachs, that all the products of assimilation at some time take the form of starch.

Using the half-leaf gravimetric method devised by Sachs, the authors confirm his results as to the rate of assimilation, but they show that only a small portion of this assimilated material exists at any one time in the form of *starch.*

The starch in leaves was estimated by hydrolysing it, with suitable precautions, with the aid of diastase, and then determining the products of its hydrolysis in the usual way by means of the polarimeter and Fehling's solution. The fluctuations in the amount of starch in leaves under various conditions, and also in leaves plucked at different times in the day, have been determined by this method.

It is shown that Wortman's recent denial that diastase plays any part in the dissolution and translocation of starch in leaves is incorrect. The authors prove that, instead of leaves containing little or no diastase, every leaf examined by them contained sufficient diastase to transform far more starch than the leaf can have contained at any one time; in many cases sufficient diastase was present to hydrolyse an amount of starch many times the total dry weight of the leaf. The difference between the authors' and Wortmann's results is chiefly due to the fact that whereas Wortmann examined the clear filtrate obtained by macerating the crushed leaves in water during a few hours, they have digested the air-dried and powdered leaf itself with soluble-starch solution.

It is further shown that the products of the hydrolysis of starch by leaf-diastase are identical with those formed by malt-diastase, maltose having been directly separated from the leaves and its optical and reducing properties determined. Leaf-diastase is not able to convert maltose into dextrose, but the leaf contains an enzyme capable of inverting cane-sugar.

In the course of a large number of comparative determinations of the diastatic activity of various leaves, it was found that the amount of diastase varied greatly in different plants, and within narrower limits even in the same plant at different times. It is very high in the case of the Leguminosæ, the diastatic activity of *Pisum sativum* being between one-half and one-third of that of an average pale barley-malt.

An attempt to ascertain if the fluctuations in diastase were in any way periodic, or were governed, as are the fluctuations of starch in the leaf, by any external conditions, showed that any conditions which favour a decrease in the leaf-starch result in an increase of the leaf-diastase ; for instance, leaves kept in darkness, either on or apart from the plant, show a marked increase in diastatic activity. In view of the results obtained in their former paper on the Germination of the Gramineæ (Trans., 1890, 458), the authors explain this by the assumption that as long as the conditions favour assimilation, the leaf-cells are necessarily supplied with an abundance of newly assimilated materials in the form of sugars, more, in fact, than can be easily made use of or translocated, the excess of nutritive material being in part deposited as starch. At this period there is little or no elaboration of diastase by the cell-protoplasm, probably none at all in those cells in which starch-deposition is actually going on. When the light fails, and assimilation consequently falls off, the living cells speedily use up or translocate the excess of assimilated products, such as cane-sugar, and begin to draw their supplies from the more permanent starch. To enable the cells to do this effectually, the somewhat starved protoplasm now commences to elaborate the needed diastase more rapidly, and the secretion of the enzyme becomes accelerated as the starvation point of the cell is reached, the secretion of diastase by the leaf-cell being, in fact, like that of the embryo of the grasses, to some extent a *phenomenon of starvation.* Experiments confirmed this view.

Contrary to Wortmann's statement, it was found that under certain conditions leaf-diastase can attack the solid starch-granule; but attempts to obtain any evidence of the disappearance under the influence of the contained diastase of starch in killed leaves gave negative results, and the authors are led to the conclusion that the *first stage* of dissolution of the starch-granule in the leaf is in some way or other bound up with the *life* of the cell. When, however, all the facts are considered and due weight given to (1) the constant and abundant occurrence of diastase in leaves, (2) to the apparent correlation of this diastase with the occurrence of starch, (3) to the remarkable periodicity of the rise and fall of diastase, and (4) to the correlation of this periodicity with the appearance and disappearance of starch, it is impossible to accept Wortmann's view that the dissolution of starch in the leaf is in no way conditioned by a starch-dissolving enzyme. On the contrary, the authors believe that their experiments establish beyond all doubt the physiological importance of diastase as an active agent in the dissolution and translocation of starch, not only in leaves but also in the growing parts of all plants. As further evidence of this, the authors adduce the fact that *maltose* was found amongst the sugars of the leaf when the starch was disappearing.

Selecting the leaves of *Tropæolum*, experiments were carried out to ascertain the nature of the leaf-sugars and the variations in amount and relative proportions at different times, and also for the purpose of throwing some light on the relation which each sugar bears to the primary assimilation products on the one hand, and to the leaf-starch on the other, *i.e.*, to ascertain which are the the true "up-grade" sugars from which starch is formed and which are the "down-grade sugars resulting from the hydrolysis of starch.

The only sugars found were *cane-sugar*, *dextrose*, *levulose* and *maltose*. The total amount of the sugars is subject to great variations, and the relative proportion which they bear to each other is also very varied. The results obtained lead to the following conclusions: Cane-sugar is the first sugar to be synthesised by the assimilatory processes. This sugar accumulates in the cell-sap of the leaf-parenchyma when assimilation is proceeding vigorously, and when the concentration exceeds a certain point starch commences to be elaborated by the chloroplasts at the expense of the cane-sugar. This starch forms a more stable reserve-material than the cane-sugar and is only drawn on when the latter more readily metabolised substance has been partially used up. Cane-sugar is translocated as dextrose and levulose, and the starch as maltose. From the invert-sugar derived from the cane-sugar, the dextrose is more readily used up for the respiratory processes, and possibly also for the new tissue-building, than is the levulose: hence in a given time more levulose than dextrose must pass out of the leaf into the stem.

Discussion.

The President, after remarking that a more suggestive paper had never been brought under the notice of the Society, referred to the statement made by the authors regarding the origin of the research as a striking illustration of the advantage to be derived from the association with our manufacturing industries of thoroughly qualified scientific men. A research originally commenced with the object of explaining a common brewery practice had not only afforded the required information, but in addition improved methods of analysis had been devised in the course of the work; and facts had been discovered which ultimately might serve as the basis for the interpretation of the manifold changes involved in the formation and degradation of carbohydrates in plants, and which also might largely contribute to the solution of purely theoretical problems concerning the nature of the carbohydrates. He was not prepared to allow the interpretation of the manner in which cane-sugar was formed that had been put forward by Messrs. Brown and Morris to pass unchallenged. On a previous occasion, when discussing their paper on the Germination of the Gramineæ, he had suggested that perhaps cane-sugar was formed from maltose, and not from dextrose and levulose, to unite which all attempts hitherto made had failed: that, in fact, one of the dextrose residues of maltose was converted into levulose, and that the compound thus formed underwent a change—an internal condensation—resulting in the production of cane-sugar, the nature of which even yet is not understood, but which, apparently, does not contain aldehydic groups. The evidence now brought forward was, he thought, compatible with this view. Such a passage from maltose to cane-sugar would be of advantage to the plant, as it would then have at disposal a material that was hydrolysed more easily than maltose; the superior nutritive value of cane-sugar might be due at least partly to this fact. Levulose perhaps played a special part in certain metabolic processes; it was well known to be much more sensitive than dextrose towards hydrolytic agents, the formation of levulinic acid being an instance of this, and it was not improbable that it was therefore of superior value in comparison with dextrose and other carbohydrates, because able to take part in some of the changes involved in the elaboration of tissue to which other carbohydrates, on account of their stability, were at least less readily amenable.

Mr. Thiselton Dyer said that he was much mistaken if this paper did not prove to be one of the most important contributions to the study of plant metabolism of the century. The problems involved are open to two lines of attack, the botanical and the chemical: neither, in his opinion, could lead to wholly satisfactory results. It was Mr. Horace Brown's singular merit that he had been able to combine both; his conclusions may therefore be expected to be convincing both to the botanist and to the chemist.

It was not too much to say that botanists have long waited for the work which Mr. Horace Brown and his colleague are doing and have done. A good many years ago Dr. Hugo Muller had pointed out to him how far in advance in these matters the botanical results were of those which chemists had reached. And to a botanist not the least interesting feature in this paper was the frank recognition of the value, from a chemical point of view, of the classical work accomplished in this field by Sachs and Schimper. The botanical attack had for the time, however, gone as far as it could, and it awaited the chemical complement which it is now in a fair way to receive.

The primary fact of plant "assimilation" is assumed. That is an outcome of protoplasm activity, the details of which we need not discuss. The result is generally admitted to be what we may call a "proto-carbohydrate." Now this substance reveals itself in a visible and derivative form, on the one hand in cellulose and on the other in starch. The deposition of the former is the work of the general protoplasmic body of the cell; that of the latter is, as far as we know, the special function of certain specialised protoplasmic corpuscles, known as plastids. Of these botanists now recognise three separate groups —chloroplastids, chromoplastids and leucoplastids. The latter are identical with the amyloplasts of Schimper. We now have reason to believe that these groups may be reduced to two—the coloured and the colourless plastids; the chloroplastids in point of fact are only a particular phase of the chromoplastids. All alike possess the common property of determining the formation of "starch-granules." The more we know of these bodies the more remarkable are their properties; they appear to have their own independent method of multiplication by division; it is even probable that they are bodily inherited from one plant generation to another; and both Schimper and Lankester have hinted that they may be autonomous organisms leading a commensal existence with the plant whose physiological needs they so conspicuously subserve.

Nothing is so remarkable in the general survey of plant metabolism as the repeated passage of its products from the soluble to the insoluble form, and *vice versâ*. He had long been of opinion that the key to the *modus operandi* of these transformations is to be found in the action of enzymes, and had done his best to emphasise the view in an address which he gave to the British Association in 1888. But in science a merely theoretical view is of little value without a formal proof. And as regards the mode in which starch is brought into use, it appeared to him that Mr. Horace Brown had for ever set that question at rest. The difficulties raised by Wortmann never weighed much with botanists, and Mr. Horace Brown had demolished them, as it seemed to him, for ever.

So far we were very grateful to the authors of the paper for clearing the way for us. But what follows was not, at present, free from difficulty. The botanical point of view was briefly stated by Sachs in the case of the sugar-beet: starch in the leaf, glucose in the petiole, cane-sugar in the root. As he had pointed out in the *Kew Bulletin* for 1891, the facts in the sugar-cane seem to be strictly comparable. Cane-sugar the botanist looks on, therefore, as a "reserve material." He had ventured, in fact, to call "glucose" the sugar "currency" of the plant, cane-sugar its "banking reserve."

The immediate result of the diastatic transformation of starch is not glucose, but maltose. But Mr. Horace Brown had shown in his remarkable experiments on feeding barley embryos that, while they can readily convert maltose into cane-sugar, they altogether fail to do so with glucose. We may conclude, therefore, that glucose is, from the point of view of vegetable nutrition, a somewhat inert body. On the other hand, evidence is apparently wanting that maltose plays the part in vegetable metabolism that might be expected of it. Its conversion into glucose may be perhaps accounted for by the constant presence in plant tissues of vegetable acids. But, so far, the change would seem to be positively disadvantageous. Perhaps glucose, in the botanical sense, will prove to have a not very exact chemical connotation.

That the connection between cane sugar and starch is intimate is a conclusion to which both the chemical and the botanical evidence seems to point. And on botanical grounds this would seem to be equally true of its connection with cellulose.

It must be confessed, that the conclusion that "cane-sugar" is the first sugar to be synthesised by the assimilatory processes is one which is rather startling to the botanist. It seems hard to reconcile with its probable high chemical complexity and with the fact that, botanically, it seems to stand at the end and not at the beginning of the series of metabolic change.

A few words must be said, in conclusion, on the references made by Mr. Horace Brown to the part played by protoplasm.

"Protoplasmic continuity" is a great induction, to the establishment of which the work accomplished by Mr. Gardiner at Kew had, in great measure, contributed. He was, however, inclined to approach with caution the use Mr. Horace Brown had made of it. He was far, himself, from thinking that it can at present be relied on to explain the "rapid translocations" of metabolites. For his part, for various reasons, he had been content to think that, where a tract of tissue becomes the seat of an enzymic action (as in germination), the continuous protoplasm may act as the means of transmission of an enzyme from cell to cell, or even of some influence by which an enzyme is set free from a zymogen. But he doubted the evidence at present being sufficient to accept it as the path of the bodily transmission of a metabolite.

The resistance which living protoplasm presents to the ordinary physical processes of diffusion is an old difficulty. Invoking the continuity of protoplasm did not in his opinion materially dispose of it. But, on the other hand, it must be remembered that the cell which is the active seat of metabolic change is in a state of tension; and the opposition offered by protoplasm to diffusion is mitigated by the fact that it cannot be invariably regarded as a continuous membrane, but is itself, under such circumstances, frequently porous and subject to physical permeability.

He must finally relieve his mind of an idea that had often occurred to him about protoplasm as the seat of chemical changes of immense importance. In the laboratory we are accustomed to deal with organic substances as comparatively stable. Their molecular up-building or synthesis, when effected by the chemist, is generally difficult and circuitous. He thought we must accustom our minds to the fact that in the "protoplasmic field" these processes may be much more easily accomplished. Under such circumstances it appeared to him that the molecules of various substances may be subject to soliciting influences, of the nature, perhaps, of solution, which, without altering their chemical identity or constitution, may make their chemical transformation far more easy to accomplish than it is by ordinary chemical means. He was not desirous of violating chemical order or law, or of claiming for protoplasm any "vitalistic" properties. But at the same time it would be absurd to shut our eyes to the unique properties that protoplasm possesses or to refuse to admit that it may, in consequence, have the power of conditioning chemical change in a probably unique manner. At any rate he might point to the facility with which, in the field of organic nature, chemical change seems to be effected, and to the profusion of products which result from it. What nature, with the aid of protoplasm, appears able to effect with extreme facility the chemist can only follow with laborious difficulty.

No doubt it may be said that this is to introduce a new and unknown quantity into chemistry—a biological element in fact. Why not? He could conceive that the path of chemical change in the organism may be conditioned by adaptive requirements, by natural selection in fact, and that the substances which now dominate the chemistry of plant life may have attained their prominence, not so much in obedience to unselective chemical change as to the requirements of plant life. Enzymes, for example, may, in the first place, have been mere proteid derivatives of protoplasm. But their peculiar properties of bringing about fermentative change may have rendered possible, and, therefore, stereotyped, the whole series of plant metabolism, with its singular alternation of soluble and insoluble products.

Dr. D. H. Scott said that since the publication of Schimper's paper of 1885, the idea that starch is not the first product of assimilation had been familiar to botanists. In fact, Sachs himself had never said that it was so, but had spoken of starch as the first *easily demonstrable* product. Botanists generally supposed, with Schimper, that glucose, or some similar sugar, is a prior product to starch. Messrs. Brown and Morris's conclusion that cane sugar is first formed was an entirely new departure.

The paper proved that the starch formed by the chloroplasts is precisely the same thing as starch formed by leucoplasts, namely, a reserve food substance, and nothing more. So far, the chloroplast is physiologically as well as morphologically identical with an amyloplast destitute of chlorophyll. But the chloroplast has the further, quite distinct, function of forming a carbohydrate, in the first instance, from inorganic materials.

Messrs. Brown and Morris had shown what brilliant results might be attained when skilled chemists devoted themselves to physiological problems.

Professor Green, after alluding to the author's theory of the improbability of all the carbonaceous material of the plants' food passing through the starch stage, referred to the possibility that at the same time that the formation of carbohydrate was taking place there might be a coincident formation of vegetable acids, part of the increase in weight of the leaf being so accounted for; thus from formaldehyde it seemed possible to pass to formic acid, and subsequently to higher acids such as the parenchyma of the plant contains.

He asked also whether in noticing the variation of the diastatic power of the leaf at different times of the day the authors' attention had been directed to a possible inhibitory effect of light upon its action. The quantity might vary as the author suggested, but it was at least possible that with a constant quantity the diastatic action might be much less in the day time, owing to the diastase being unable to work in sunlight.

In this connection, Professor Marshall Ward's experiments on the bactericidal action of certain rays were significant, as they indicated a possibility of protoplasm being directly affected by these rays. If protoplasm itself is so interfered with, might not its enzymes also be disturbed by the same influence?

The views of Böhm and Baranetzky as to the diastase being used up in course of its activity are not in accord with the opinion of most workers on the enzymes. As Mr. Brown appeared to endorse these views to a certain extent, could he quote experiments clearing up the point? O Sullivan's experiments on invertase (Trans., Oct., 1890) pointed to a directly opposite view.

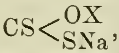
In criticising Wortmann's method of preparing his extracts, Mr. Brown had pointed out the difficulty of extracting enzymes by water. There was another solvent which, in many cases, offered great advantages, viz., a 5 per cent. solution of common salt. The greater power of this as an extractive was possibly connected with the frequent association of the enzymes with globulins.

Dr. Lauder Brunton observed that the paper opened up very many new lines of enquiry. It threw a light not merely on vegetable physiology and chemistry, but on the physiology of animal life and also on that of the lowest organisms which could hardly be reckoned either as animal or vegetable. He thought that perhaps animal life in its turn might throw a light on vegetable physiology, and instanced the close resemblance that existed between the storage of glycogen in the liver of animals during digestion with its subsequent conversion into sugar and the temporary accumulation of starch and its subsequent removal from the leaves of plants. In the pancreas of an animal, one of the enzymes which was present in the juice of the secreting gland and also in its substance appeared to be entirely absent from the gland of fasting animals. This absence is only apparent, for the enzyme is really present, not in an active condition, but in the form of a zymogen. From this zymogen the active enzyme may be liberated by treatment with dilute chlorhydric acid and subsequent neutralisation. He was desirous to know whether any such zymogen had been found in leaves where starch was accumulating. The pancreas of animals was also remarkable in this particular, that while the gland was pouring into the intestines a juice which converts starch into sugar, it was also pouring through the lymphatics into the blood an enzyme which destroys sugar. He thought it possible that more than one enzyme might be present in the leaves of plants, and was anxious to know whether any observation had been made as to the presence of an enzyme in the plant which could decompose sugars.

*2. "The interaction of alkali cellulose and carbon disulphide: cellulose thiocarbonates." By C. F. Cross, E. J. Bevan and C. Beadle.

Alkali cellulose has been further investigated by the authors, both in the form known as "mercerised" cellulose (cotton) and int he form of gelatinous hydrates which dissolve in alkaline solutions. The corresponding benzoates which have been prepared afford evidence as to the number of active OH groups; the maximum appears to be four, cellulose being expressed as $C_{12}H_{20}O_{10}$.

Cellulose thiocarbonates result from the interaction of alkali cellulose and carbon disulphide in the molecular proportions $C_{12}H_{20}O_{10}$: 4NaOH : $2CS_2$: 30—40H_2O. The product swells up enormously on treatment with water, and finally completely dissolves, but undergoes change, hydrated cellulose and products of interaction of the alkaline hydrate and carbon disulphide being formed.

From the study of the composition of a large number of these products, the authors are led to assign to the series of compounds the general formula  $CS{<}\genfrac{}{}{0pt}{}{OX}{SNa}$, X representing the cellulose "residue" or rather an alkali cellulose residue or radicle of variable dimensions.

These thiocarbonates of cellulose yield solutions of extraordinary viscosity, and from the property they possess of undergoing change regenerating cellulose, promise extended applications. The further investigation of the compounds is in progress.

In conclusion, the bearings of the results and other recent contributions to cellulose chemistry are discussed with reference to the molecular constitution of the typical members of the series.

3. "Sulphocamphylic acid." By W. H. Perkin, jun.

In the course of a series of researches on camphoric acid and its derivatives, the author has for some time been engaged in submitting to detailed examination the sulphocamphylic acid which Walter (*Jahresb.*, **21**, 272; **24**, 392) first prepared by heating camphoric acid with sulphuric acid. In the formation of this acid, quantities of carbonic oxide are evolved, the decomposition being apparently represented by the equation $C_{10}H_{16}O_4 + H_2SO_4 = C_9H_{16}SO_6 + H_2O + CO$.

After carefully verifying the formula of sulphocamphylic acid by the analysis of the acid and of some of its salts, the author next studied the behaviour of the acid on distillation. When small quantities of the acid are rapidly heated in small retorts, vigorous decomposition takes place, a small quantity of a colourless oily substance, which soon solidifies, passing over, a large amount of carbonaceous matter being left in the retort.

After recrystallisation from formic acid, the solid product melts at 134—135°; on analysis it gives numbers agreeing with the formula

$C_9H_{14}O_2$, and is a monobasic acid, its formation from sulphocamphylic acid being apparently represented by the equation $C_9H_{16}SO_6 = C_9H_{14}O_2 + H_2SO_4$; it yields a silver salt of the formula $C_9H_{13}AgO_2$. The acid distils with only slight decomposition, and volatilises with steam; it dissolves in cold sulphuric acid without decomposing, but on warming the solution at 90° a sulphonic acid is readily formed: this appears to be regenerated sulphocamphylic acid, but no analysis of the product has as yet been carried out.

A neutral solution of the sodium salt of sulphocamphylic acid is readily oxidised by potassium permanganate at 0°, forming a variety of products: from these the author has succeeded in isolating small quantities of a beautifully crystalline compound, melting at 254°, which on analysis was found to possess the remarkable formula $C_{18}H_{22}O_7$. This substance is a dibasic acid, the silver salt having the formula $C_{18}H_{20}O_7Ag_2$; when heated at 140° the acid loses 1 mol. prop. of water, and is converted into a compound of the formula $C_{18}H_{20}O_6$.

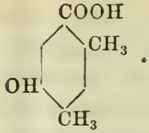
The *dimethylic salt*, prepared by treating the compound of the formula $C_{18}H_{22}O_7$ with methyl alcohol and sulphuric acid, has the formula $C_{20}H_{24}O_6$, instead of $C_{20}H_{26}O_7$ as might have been expected.

The compound of the formula $C_{18}H_{22}O_7$ affords a *dihydroxime* $C_{18}H_{22}N_2O_6$, which crystallises from ether in scales which do not melt at 250°. Excess of acetic anhydride converts this hydroxime into a *monoacetate*, $C_{18}H_{21}N_2O_6(C_2H_3O_2)$, m. p. 195°. By the action of phenylhydrazine it is converted into a dihydrazone, $C_{30}H_{34}N_4O_5$; this compound crystallises from acetic acid in brilliant red prisms which decompose at 232°.

The acid of the formula $C_{18}H_{22}O_7$ is readily reduced by sodium amalgam, combining with 2 atoms of hydrogen and losing 1 mol. of water, the product having the composition $C_{18}H_{24}O_6$. This reduction product is a dibasic acid, which does not melt at 300°; the *silver salt*, $C_{18}H_{22}Ag_2O_6$, was analysed.

Among the many remarkable decompositions of the substance of the formula $C_{18}H_{22}O_7$, the investigation of which is not concluded, the behaviour of this acid towards sulphuric acid is perhaps the most interesting. The acid readily dissolves in concentrated sulphuric acid; if the solution be warmed at 90—95° decomposition rapidly takes place, and on pouring the product into water a yellow, flocculent substance separates which is a new monobasic acid of the formula $C_9H_{10}O_3$; the formation of this acid may be represented by the equation $C_{18}H_{22}O_7 = 2C_9H_{10}O_3 + H_2O$.

A careful investigation of this compound has proved that it is a *hydroxymetaxylenecarboxylic acid* of the constitution represented by the formula



In the course of the prolonged investigation of this acid which was necessary before its constitution could be determined, the following derivatives were prepared and analysed.

Silver salt, $C_9H_9O_3Ag$; *dimethylic salt*, $C_9H_8O_2(OCH_3){\cdot}CH_3$ (oil); *methylic salt*, $C_9H_8O_2(OH){\cdot}CH_3$ (m. p. 149°); *isomethylic salt*, $C_9H_8O_2(OCH_3)H$ (m. p. 171°); *diethylic salt*, $C_9H_8O_2(OC_2H_5){\cdot}C_2H_5$ (m. p. 51°); *ethylic salt*, $C_9H_8O_2(OH){\cdot}C_2H_5$ (m. p. 135°); *isoethylic salt*, $C_9H_8O_2(OC_2H_5)H$ (m. p. 174°).

A *dinitro-acid* of the formula $C_9H_8(NO_2)_2O_3$, formed by the action of nitric acid; this crystallises in yellow needles which melt at 203—205°; it behaves as a dibasic acid, giving a silver salt of the formula $C_9H_6Ag_2(NO_2)_2O_3$.

When exposed to the action of bromine vapour, it is converted into a *dibromo-derivative*, $C_9H_8Br_2O_3$, which crystallises in colourless prisms and melts at 205°.

The isomethylic salt is readily oxidised by an alkaline solution of potassium permanganate, yielding a substance of the formula $C_7H_5(OCH_3)(COOH)_2$, which crystallises in colourless needles melting at 250°. When heated with a fuming solution of hydrogen iodide, this dibasic acid is readily decomposed, yielding the corresponding phenolic compound, $C_7H_5(OH){\cdot}(COOH)_2$, which on investigation has proved to be identical with the *hydroxymethylterephthalic acid* of the formula $OH : CO_2H : Me : CO_2H = 1 : 2 : 4 : 5$, prepared by Jacobsen (*Ber.*, **16**, 191). This result proves that the acid of the formula $C_9H_{10}O_3$ has the constitution assigned to it above, *i.e.*, that of hydroxymetaxylenecarboxylic acid, $(COOH : CH_3 : CH_3 : OH = 1 : 2 : 4 : 5)$.

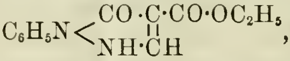
The author hopes in a short time to be able to publish the details of these and many other experiments not mentioned in this abstract, and to be in a position to explain the relationship between the compounds represented by the formulæ $C_{18}H_{22}O_7$ and $C_9H_{10}O_3$; as also to suggest a constitutional formula for sulphocamphylic acid.

4. "Magnesium diphenyl." By Lothar Meyer.

W. R. Hodgkinson, in a recent note in these Proceedings (1893, p. 80), refers to a substance not yet obtained pure which he suggests may be magnesium phenyl; this induces me to state that magnesium diphenyl was prepared in my laboratory last year by Hermann Fleck and described by him in his inaugural dissertation ("Ueber Magnesium Alkyle." Tübingen, 1892), and that an account of his work will be published in Liebig's *Annalen.*

Magnesium diphenyl, $MgEt_2$, is obtained by the interaction of magnesium and mercury diphenyl at 200—210° in the form of a very voluminous powder, insoluble in all ordinary liquids, but soluble in a mixture of ether and benzene. It is spontaneously inflammable; on slow oxidation it yields a phenate; water converts it into benzene and magnesium hydrate; it affords bromobenzene and magnesium bromide on treatment with bromine, triphenylmethane on treatment with benzal chloride, and diphenylphosphine chloride and more complex compounds when subjected to the action of phosphorous chloride. It has the advantage over mercury diphenyl that it readily exchanges both phenyls for other radicles, and does not yield a compound corresponding to mercury phenyl chloride. The study of the magnesium alkyls is being continued in the Tübingen Laboratory.

5. " The formation of pyridine derivatives from unsaturated acids." By S. Ruhemann, Ph.D.

An account is given of the continuation of previous work by the author on the same subject. It is now shown that *ethylic methyldicarboxyglutaconate* is converted by aqueous ammonia into *methylmalonamide* and *ethylic amidoethylenedicarboxylate*, and that phenylhydrazine acts on it, forming *ethylic methylmalonate* and the ammonium compound of the *pyrazolon*,  $C_6H_5N\Big\langle\begin{matrix}CO\cdot\underset{\|}{C}\cdot CO\cdot OC_2H_5\\ NH\cdot CH\end{matrix}$, which has been previously described.

Ethylic methylglutaconate is converted by the action of aqueous ammonia into *β-methyl-αα'-dihydroxypyridine*; on reduction with zinc-dust, the compound furnishes β-picoline; on oxidation with ferric chloride, it affords a yellow colouring matter.

Ethylic ethyldicarboxylglutaconate is converted by aqueous ammonia into *ethylmalonamide* and *ethylic amidoethylenedicarboxylate;* and by phenylhydrazine into a *pyrazolon* and *ethylic ethylmalonate.*

When heated with aqueous ammonia in a closed tube at 100°, *ethylic ethylglutaconate* is converted into *ethylic dihydroxypyridine*, which yields a yellow colouring matter, probably a hydroxyquinone, on oxidation with ferric chloride.

6. " Chlorinated phenylhydrazines. Part II." By J. T. Hewitt, Ph.D.

The author, in continuation of his previous work, describes the *sulphate* and *oxalate* of *orthochlorophenylhydrazine.* Unlike the meta- and para-derivatives, this hydrazine does not form a urazole when heated with biuret. The ethylic salt of the hydrazone of pyruvic acid occurs in yellow needles melting at 68°, not at 168° as previously stated; it is insoluble in alkalis.

Metachlorophenylhydrazine, which has been prepared and described by Willgerodt and Mühe, forms a crystalline *hydrochloride*, *sulphate* and *nitrate*. A solution of the hydrochloride and potassium cyanate interact to form a *semicarbazide* melting at 155°; the corresponding *thiosemicarbazide* is obtained when phenyl mustard oil is used. The hydrazine furnishes a *urazole* when heated with biuret.

The metachlorophenylhydrazone of benzaldehyde crystallises in colourless needles melting at 133—134°; the corresponding hydrazone of pyruvic acid is crystalline, and melts at 163°.

Parachlorophenylhydrazine is also shown to form a similar *semicarbazide* and *hydrazones* of benzaldehyde and pyruvic acid.

7. "The oxidation of tartaric acid in presence of iron." By H. J. H. Fenton, M.A.

If a small quantity of hydrogen peroxide be added to a solution of tartaric acid containing a trace of ferrous salt, a yellow colour is produced which changes to violet on adding alkali; an excess of the peroxide must be avoided. As other organic acids do not behave in this manner, the interaction may be utilised in detecting tartaric acid. The violet colour is discharged by acids, sulphuric acid producing a transient green coloration, and is reproduced by alkali.

The compound which gives the colour with ferric salts is crystalline, and appears to be represented by the formula $C_2H_2O_3$. It is best obtained by dissolving tartaric acid in a limited quantity of boiling water, and then adding about 1/20th of its weight of reduced iron; the liquid is then heated until clear. After the solution has been well cooled, hydrogen peroxide is carefully added drop by drop, the temperature being maintained constant until the liquid is nearly black; slightly hydrated phosphoric oxide is next added in small quantities at a time, the mixture being still well cooled, and finally the compound is extracted with ether. The ether is then distilled off, and the residue mixed with cold water; the resulting white powder is washed with a small quantity of cold water. The compound is a powerful reducing agent, and behaves as a ketone with phenylhydrazine, hydroxylamine and hydrogen cyanide. The author is further investigating the properties and constitution of the product in question.

8. " The inertness of quicklime." By V. H. Veley.

The conditions under which calcium carbonate is formed from lime and carbon dioxide have been investigated by Debay, Raoult and Birnbaum, with Mahn; but the experiments of these authors are neither described in detail, nor were they made under comparable conditions.

The experiments recorded in the paper were conducted on a much larger scale than heretofore, and the amount of combination between the lime and carbon dioxide as dependent on the conditions (1) of moisture, (2) of temperature, is investigated. It is shown that the combination is incomplete, not only with lime to which 11 per cent. of water is added, but even with the hydrate; the presence of 10 per cent. free water in the hydrate increases the absorptive power nearly fourfold. Dry carbon dioxide combines with lime to a slight extent at 300°, to a greater degree at 350° and fairly completely at 420° (melting point of zinc; *cf.* Birnbaum and Mahn).

The conditions of the formation of calcium sulphite from lime and sulphur dioxide have been studied by Birnbaum and Wittich, who do not, however, give any quantitative results.

It is here shown that lime and sulphur dioxide, when dry, begin to combine at about 300°, and more completely at 352°; but at a higher temperature the resulting sulphite is decomposed into sulphate and sulphide, and by the interaction of the latter and the sulphur dioxide sulphur is formed.

There is a great similarity in the behaviour of dry carbon and sulphur dioxides as regards the amounts of them absorbed by lime under the same conditions of temperature. Incidentally it is noted that quicklime does not absorb nitrous fumes at ordinary temperatures.

It is proposed to continue these investigations.

9. " The products of the interaction of tin and nitric acid." By C. H. H. Walker.

This investigation is a continuation of the investigations of Veley on the conditions of the interactions of metals and nitric acid.

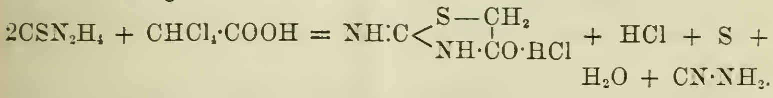
Since the work was commenced, a paper by Clemente Montemartini on the same subject has appeared.

It is generally stated in manuals on chemistry that metallic tin dissolves in nitric acid forming both a stannous and stannic salt, according to the conditions of temperature and concentration of acid, but it does not appear that this statement is based on quantitative investigations.

In the paper determinations are given of the amounts of stannous salt formed according to the conditions of (1) mass of metallic tin; (2) temperature; and (3) concentration of acid. It is shown that the proportion of stannous salt formed is but little affected by the mass of tin, and in the case of dilute acids by increase of temperature, but with more concentrated acids the effect is more marked, so that an alteration of a few degrees reduces the amount of stannous salt to *nil*. Increase of concentration of acid, other conditions remaining the same, decreases the proportion of stannous salt. The white, or yellowish-white, substance deposited from fairly concentrated solutions is a hydrated stannic nitrate of rather indefinite composition (*cf.* Clemente Montemartini). The average value of a number of analyses corresponded most nearly with a formula $Sn(NO_3)(OH)_3$. The substance appears to slowly decompose on exposure, so that the composition varies not only with the time elapsing between its production and analysis, but also according to the method of purification adopted to eliminate nitric acid.

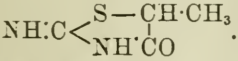
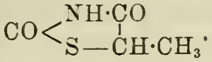
10. "Interaction of thiourea and some haloid derivatives of fatty acids." By Augustus E. Dixon, M.D.

On warming thiourea with dichloracetic acid, either alone or in solution (in water or in dilute spirit), hydrogen chloride is evolved, sulphur and thiohydantoic acid are deposited and the filtered solution on standing, yields orthorhombic crystals of thiohydantoin hydrochloride. The formation of this latter substance may be expressed in the following manner:—



$$2CSN_2H_4 + CHCl_2\cdot COOH = NH{:}C<\begin{matrix}S-CH_2\\ NH\cdot CO\cdot HCl\end{matrix} + HCl + S + H_2O + CN\cdot NH_2.$$

In the case of trichloracetic acid, complete decomposition occurs, carbonic anhydride, hydrogen chloride, hydrogen sulphide, sulphur and chloroform being produced. Ethylic trichloracetate in boiling alcoholic solution has scarcely any action.

α-Monochlor- (or brom-) propionic acid and thiourea readily interact, yielding the hydrochloride (or hydrobromide) of methylthiohydantoin,  $NH{:}C<\begin{matrix}S-CH\cdot CH_3\\ NH\cdot CO\end{matrix}$. The latter compound, separated from its salts by caustic alkali, crystallises from alcohol in brilliant, vitreous prisms; it melts at 205—206° (uncorr.), but is decomposed. It is not desulphurised, either by treatment with silver salts or with alkaline lead solution; on boiling with baryta-water, it yields methylthioglycollic acid. On boiling with chlorhydric acid, ammonium chloride is produced, together with a substance crystallising in needles; this was not obtained in a pure condition, but from the mode of production, and the ready manner in which it undergoes conversion into methylthioglycollic acid, it must be β-methyldioxythiazole, 

$$\mathrm{CO}<\begin{array}{l}\mathrm{NH\cdot CO}\\ \qquad\ \ | \\ \mathrm{S-CH\cdot CH_3}\end{array}.$$

NOTICE TO AUTHORS OF PAPERS.

Authors are particularly requested to send their papers to the Secretaries, at Burlington House, *not later than the Monday previous to the meeting at which they are to be read.*

In all cases an abstract of each paper should be supplied for insertion in the "Proceedings."

HOFMANN MEMORIAL MEETING.

This meeting will be held on Friday, May 5th, at 8 P.M., when addresses will be delivered by Right Hon. Lord Playfair, Sir F. A. Abel and Dr. W. H. Perkin.

At the next meeting there will be a ballot for the election of Fellows, and the following papers will be read:—

"The hydrates of potassium, sodium and lithium hydroxides." By S. U. Pickering, F.R.S.

"Notes on Marsh's and Reinsch's tests for arsenic." By J. Clark, Ph.D.

"The formation of hydrogen peroxide in organic liquids." By A. Richardson, Ph.D.

"The supposed saponification of linseed oil by white lead." By J. B. Hannay and A. Leighton.

"Notes on the capillary separation of substances in solution." By L. Reed.

HARRISON AND SONS, PRINTERS IN ORDINARY TO HER MAJESTY, ST. MARTIN'S LANE.

Issued 18/5, 1893.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

No. 124. Session 1893-94.

May 4th, 1893. Dr. Armstrong, President, in the Chair.

Certificates were read for the first time in favour of Messrs. John Bateman, Saltney, near Chester; Robert S. Cahill, 90, Park Lane, Norwich; Alexander Mitchell Martin, Douglas Villa, Dunbeth Road, Coatbridge; Charles Alexander McKerrow, 41, Eccles Old Road, Pendleton, Manchester; William Ridgely Orndorff, Ithaca, N.Y., U.S.A.; Wilfred Sessions, Russell House, Gloucester; Frank Ernest Thompson, 97, Murdock Road, Handsworth, Birmingham.

In answer to a question put by Mr. Cassal, the President expressed the opinion that to read the certificates of some, without reading those of all, candidates would be to make an invidious distinction, and that therefore, if such a request were made, he should rule that it was out of order.

The following candidates were duly elected Fellows of the Society:—John Frederick Briggs, Julian L. Baker, William A. Bone, Laurence Augustus Baine, John Charles Burnham, William Robert Burnett, Joshua Buchanan, Ralph Edward Brown, George Clayton, James Cameron, Harry Williamson Dixon, H. W. Dickinson, Robert Cecil Turle Evans, Thomas Edwards, Alfred Roland Gower, Robert George Grimwood, John Addyman Gardner, Hedley Gordon Jones, Hooper Albert Dickinson Jowett, Sorabji Manekji Kaka, Edmund George Lamb, Herbert Lloyd, Alan E. Munby, Henry John Monson, John Alan Murray, J. Frank McGregory, A.B., A.M., James Mason, Raffaéllo Nasini, William Henry Oates, S. Parrish, William Rintoul, James Henry Robbins, George Rudd Thompson, Frank P. Vandenbergh, B.S., M.D., A. F. Watson, John Wilkinson.

Of the following papers those marked * were read :—

*11. "The hydrates of sodium, potassium and lithium hydroxides." By S. U. Pickering.

By cooling solutions of sodium hydroxide the author has succeeded in isolating a large number of hydrates in the solid crystalline condition. They considerably outnumber those of which he obtained indications by means of changes of curvature in the case of sulphuric acid—comparing similar ranges of strengths in the two cases—and hence no improbability can any longer be held to attach to these latter on account of their being so numerous.

The formula of the various hydrates isolated and their freezing points are as follows :—

$NaOH{\cdot}H_2O$	f. p.	64·3°
$NaOH{\cdot}2H_2O$........	,,	12·5
$NaOH{\cdot}3{\cdot}11H_2O$	,,	2·73°
$NaOH{\cdot}3{\cdot}5H_2O$	,,	15·55
$\alpha NaOH{\cdot}4H_2O$........	,,	7·57
$\beta NaOH{\cdot}4H_2O$........	,,	− 1·70
$NaOH{\cdot}5H_2O$........	,,	−12·22
$NaOH{\cdot}7H_2O$........	,,	−23·51

The freezing points or solubility curves of all these hydrates have been followed throughout considerable ranges; several of them—in one case as many as four—overlap each other. As it is scarcely possible to conceive that a crystalline hydrate can be extracted from a solution unless some molecules of that hydrate are present in the solution, this fact must prove that in some cases as many as four, probably even more, different hydrates exist in the same solution.

The existence of two different tetrahydrates is noticeable, as also is that of the complex hydrate of the formula $NaOH{\cdot}3{\cdot}11H_2O$ or $NaOH{\cdot}3H_2O + NaOH{\cdot}4H_2O$, which is similar to two of the hydrates of which the author obtained indications in the case of sulphuric acid. Of the eight hydrates, that containing 3½ mol. props. of water is the only one which has been previously described.

In the case of potassium hydroxide, two new hydrates—a mono- and a tetra-hydrate—have been isolated and examined, in addition to the already known dihydrate. The freezing points of these are

$KOH{\cdot}H_2O$..........	f. p.	143°
$KOH{\cdot}2H_2O$	,,	35·5°
$KOH{\cdot}4H_2O$	,,	− 32·7

In the case of lithium hydroxide, the already known monohydrate was the only one obtained.

12. "Detection of arsenic in alkaline solution." By John Clark, Ph.D.

The author shortly reviews the different methods by which arseniuretted hydrogen is generated in an alkaline solution, and finds, as pointed out by Hager, that Fleitmann's process, which depends on the interaction of finely divided zinc and caustic potash, does not detect arsenic acid, but he is unable to confirm the statement of H. Fresenius, that Gatehouse's modification of Fleitmann's test indicates arsenic acid, as he has not been able to volatilise the slightest trace of arsenic by heating arsenate of soda with a large excess of pure aluminium and caustic soda, and he attributes the results obtained by Fresenius to the use of impure aluminium, or to the presence of arsenious acid in the arsenic acid. Experiments made to test the applicability of the Gatehouse process in estimating arsenic seem to show that, although it is very delicate and very convenient, it does give quantitative results, even when the whole of the arsenic is in the form of arsenious acid. He also finds that arsenic acid in an alkaline solution resists the action of sodium amalgam, and he concludes, therefore, that none of the methods which have been proposed for the generation of arseniuretted hydrogen in an alkaline solution detect arsenic acid.

13. "Improvements in Reinsch's process." By John Clark, Ph.D.

Reinsch's process, as carried out in the ordinary way, is capable of demonstrating the presence of very minute quantities of arsenic, and, according to Letheby, it withdraws every, and the smallest, trace of arsenic from organic mixtures, but there are two objections to its use in medico-legal cases.

1st. When the quantity of arsenic is small, a stain is obtained which it is sometimes difficult to identify as arsenic, because the coated copper when heated is apt to give a layer of chloride of copper and organic matter, instead of arsenious acid; and

2nd. It is not suitable for the quantitative estimation of arsenic, as it is not possible by means of heat to volatilise the whole of the arsenic from the copper.

The author's improvements consist in identifying the arsenic or antimony on the copper with greater certainty, and at the same time estimating the amount of each when they occur together. For this purpose he digests the coated copper in a cold mixture of dilute caustic potash and peroxide of hydrogen, which dissolves the arsenic and antimony, and converts them into arsenate and antimonate of potassium. The solution is then boiled, filtered, to get rid of the oxide of copper, evaporated to small bulk, and distilled with ferrous chloride and strong chlorhydric acid. The distillate is then saturated with sulphuretted hydrogen, and the arsenic weighed as sulphide, after being freed from traces of sulphur by washing with carbon bisulphide and alcohol. The residual liquid, from which the arsenic has been thus removed by distillation, is then tested for antimony.

DISCUSSION.

Dr. BERNARD DYER drew attention to a remarkable difference in the results obtained on testing for arsenic by Marsh's process when the zinc used was in the shape of rods instead of being granulated. Some time since he had detected arsenic, not a mere trace, but a tangible, weighable quantity, in a certain pigment, but his results were disputed by the maker of the colour, who stated that a test made with rigid precautions by another operator had afforded no evidence of the presence of arsenic. The speaker had therefore met the other operator, and the following very curious results were obtained:—An ounce or two of his (Dr. Dyer's) highly purified granulated zinc was introduced into the Marsh apparatus, together with pure chlorhydric acid; at the end of an hour no appreciable deposit was formed in the heated tube, but on introducing 2 grams of the pigment a dense arsenical mirror was soon obtained. The apparatus was then washed out, and charged with cast rod zinc, brought by the challenging operator; not only, however, was no deposit formed in the tube during the blank trial, but also on introducing 2 grams of the pigment no indication of the presence of arsenic was obtained, although the experiment was continued during an hour. Further experiments were made with this cast zinc, in which arsenious acid was deliberately added; when small fractions of a milligram were taken, and gas was slowly evolved, the arsenic was almost completely held back, and was but very partially deposited even when several milligrams were taken, the results being altogether different from those obtained on using the granulated zinc. A number of samples of cast zinc were found to behave similarly. He had no doubt that some condition, probably of a physical kind, prevailed in cast zinc that did not prevail in the case of granulated zinc. The matter required further investigation, as it was one one of obvious importance in toxicological work. There was little doubt that the arsenic is precipitated in the generating bottle. Even granulated zinc produces some precipitation. It has been already shown that the frequently advocated use of platinum in the generating bottle tends to hold back arsenic, and it seems probable that some couple may be formed in cast zinc.

*14. "The action of light in preventing putrefactive decomposition and in inducing the formation of hydrogen peroxide in organic liquids." By Arthur Richardson, Ph.D.

It was shown in 1878 by Downes and Blunt (*Proc. Roy. Soc.*, 26, 488) that the development of bacteria and other putrefactive organisms is arrested under the influence of sunlight and oxygen; Janowski, Buchner and Marshall Ward have recently made observations of a similar character. This sterilising influence of light in presence of oxygen has apparently always been regarded as the outcome of an action exercised within the organism; the author describes a number of experiments with urine, made with the object of ascertaining whether, when sterilisation has been effected by light, any oxidising agent, such as hydrogen peroxide, is formed, and whether such substance may not be the sterilising agent.

The method of testing is fully described, reliance being chiefly placed on the production of a yellow colour on the addition of a solution of titanic oxide in sulphuric acid; it is shown that this test affords a means of accurately estimating small amounts of hydrogen peroxide.

The author finds that, although no hydrogen peroxide is formed by the action of oxygen on sterilised urine in the dark, an appreciable amount is formed on exposing such urine to light, which is a proof that the production of the peroxide is not dependent on the presence of organisms. Urine in which bacteria have once flourished and which has then been sterilised at 100° no longer gives hydrogen peroxide on insolation.

Substances which destroy hydrogen peroxide were found to facilitate growth; thus, two portions of sterilised urine were exposed to light during several days, and to one of them was added a quantity of sterilised manganese dioxide; both were then placed in a dark cupboard: whereas both originally contained hydrogen peroxide, after 24 hours that to which no manganese peroxide had been added alone gave the yellow colour with titanic acid; and after 14 days, fungoid growths had developed in the liquid containing manganese peroxide, while the other portion was still clear and contained hydrogen peroxide.

Experiments are described, showing that if peroxide of hydrogen be added to fresh urine, this may be kept during a considerable period in the dark without the peroxide being entirely decomposed, and that its presence renders the liquid much less prone to undergo change under the influence of organisms, while, if added to urine in which fermentative change has already set in, it is rapidly decomposed.

15. "The supposed saponification of linseed oil by Dutch white lead."
By J. B. Hannay, F.R.S.E., and Arthur E. Leighton.

Statements are quoted from technical writers showing the existence of a belief that white lead acts on the oil in which it is ground, and even indicating that the heat given out in mixing the pigment with oil is due to the occurrence of an interaction. The authors show that no heat is given out on mixing oil and white lead without undue friction, and that the heat observed in manufacturing operations is due to the conversion of the energy of the engine into heat by friction.

Also that white lead can be freed from oil as readily as any other pigment if a sufficient quantity be used, but it requires 100 c.c. to every gram of pigment to effect a complete separation. Oleate of lead, whether basic, neutral or acid, is shown to be readily soluble in ether, and it was mixed with white lead, both dry and ground in oil, and then extracted with ether, thus proving that if present it would certainly dissolve in the ether used to extract the oil. The method of testing is described, and it is shown that by passing sulphuretted hydrogen through the ethereal solution of the oleate, the faintest trace of oleate can be detected.

A series of tests carried out on samples of Dutch white lead produced by the most eminent makers is then described, and it is shown that no trace of oleate is present in any of them, nor does any insoluble organic compound cling to the lead after the oil is extracted. It is shown that normal carbonate of lead dissolves in heated oil more readily than hydrate, and that the hydrate is actually less acted upon at high temperatures than either Dutch white lead or normal carbonate, so that the hydrate does not saponify the oil.

It is shown that so small a quantity as 0·01 of oleate will seriously darken white lead when exposed to the air, and in presence of diluted sulphuretted hydrogen the smallest quantity of oleate causes the paint to darken when the pure white lead retains its colour, showing that the formation of a lead oleate would be deleterious.

Discussion.

Mr. Harland remarked that evidence of an action between linseed oil and white lead was to be found in the fact that it was impossible to wholly remove the oil from an ordinary white lead paint by means of ether.

Mr. Bertram Blount said that the action between the linseed oil and white lead did not result in the saponification but in the oxidation of the oil, one of the products being "linoxin," which, though soluble in alcohol, was scarcely soluble in ether. This explained the fact alluded to by Mr. Harland. He took exception to Mr. Hannay's experiments, on the ground that he had used lead oleate, and not the lead linoleate which would result if any "saponification" occurred in linseed oil.

Mr. W. F. Reid drew attention to the work of Mulder and Pettenkofer, which showed that no "saponification" was effected by dry white lead. It appeared that the white lead promoted slow oxidation of the oil and not "saponification."

The President said that he failed to understand the author's object in bringing such a communication under the notice of the Society. The statements made by the writers referred to could scarcely be taken seriously; such men would probably be unable to explain what "saponification" meant. No chemist would suppose that carefully dried white lead and oil, such as the authors used, would interact when carefully mixed, or that even carefully dried caustic soda would act under such conditions. It was apparently the universal belief that Dutch white lead had certain peculiar properties, but its effect was undoubtedly a complex one, in which probably not only the white lead and oil played a part, but also moisture, air, light and time.

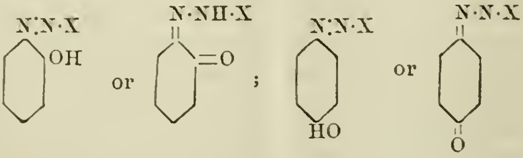
In reply, Mr. Hannay said that his experiments were made to refute the statement made in several technical manuals on paints.

16. "Notes on capillary separation of substances in solution." By Lester Reed.

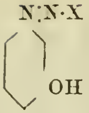
Although the separation of salts in solution by selective absorption in bibulous paper has been partly investigated by E. Fischer and E. Schmidmer (*Annalen*, **272**, 156—169), as I have, in ignorance of their experiments as well as of those of Schönbein, been recently investigating the same subject by a somewhat different method, I venture to briefly enumerate some of the observations I have made. My attention was first forcibly drawn to the subject by noticing the wide, colourless, very sharply defined margin which is obtained when a drop of moderately dilute solution of eosin (potassium eoside) is allowed to spread upon filter paper, although a saturated solution of eosin does not yield this margin. On adding potassium chromate to such a dilute solution of eosin, and repeating the experiment, the margin obtained is no longer colourless, but yellow, and the presence of chromate may be at once detected in this margin by touching it with a platinum wire moistened in a solution of silver nitrate, which produces a dark red spot on the yellow margin. If this yellow margin be cut off and extracted with water, a solution of potassium chromate free from eosin is at once obtained; and, conversely, eosin free from potassium chromate may be obtained if, after the drying of the drop. a drop of pure water be added and allowed to diffuse outwards from the centre; the appearance then obtained is that of a dark red central portion surrounded by a colourless margin, which is again surrounded by a yellow ring of potassium chromate, a practically complete separation or analysis of the mixture of the two salts being thus effected in a very short time. These, with a few other similar observations, are my initial facts, and naturally suggested the possibility of thus separating many other substances, as well as the use of porous media other than filter paper. I then observed that in some cases there was a very narrow, colourless margin outside the yellow region of a drop of potassium chromate solution which had been allowed to spread on filter paper. At first I was inclined to suspect that this appearance was merely caused by the advancing solution crushing together and driving before it, by its expansion, some moisture already present in the filter paper. To prevent the drying of the drops during their expansion, I performed most of the experiments in an atmosphere saturated with aqueous vapour, by placing the filter paper, on which the drop lay on a small porcelain dish containing a little water, covering this with a bell jar moistened on the inside with water. When thus treated, a drop of moderately dilute solution of potassium chromate affords a most unmistakable, colourless, moist margin, in which silver nitrate fails to detect chromate. After this I examined in a similar way the diffusion of a mixed solution of ferric chloride and copper sulphate, testing the marginal region, after allowing about an hour for expansion, with potassium ferrocyanide, which demonstrated the existence of a marginal ring containing copper but free from iron. In the case of a solution of ammonia alum, using as tests for ammonium and aluminium respectively Nessler's test and tincture of logwood containing ammonium carbonate, no separation of the constituents was detected, both extending to the extreme limit of moisture: so that in this case I have not obtained any free water margin, and the same remark will apply to chrome alum. Employing a mixture of the solutions of copper sulphate, ferric chloride and ammonia alum, a beautiful separation is readily effected. Externally in this case there is a ring of pure alum detectible by the logwood test, within which is an annular zone jointly occupied by copper sulphate and alum, which is shown to be free from iron by yielding a pure chocolate colour with potassium ferrocyanide; and, lastly, a central zone where all three salts are present and which is coloured dark blue by ferrocyanide, the lines of demarcation between these three zones being perfectly sharp and definite. In applying the logwood test by means of platinum wire, it is necessary to dry the minute spots and to compare them with similarly dried spots yielded by the same test on clean filter paper. In the absence of alum, the drops are buff; in its presence. purple. Mercuric chloride is a salt which, even in saturated solution, very readily gives a free water margin. Caustic potash or potassium iodide may be used as tests for it. In a mixture of solutions of lead acetate and mercuric chloride, sufficiently dilute to give no precipitate, the lead is observed to outstrip the mercury. Platinum chloride very readily gives a margin, the test employed being reduction by heat; in the case of a strong solution there is a tendency to form a double margin, which suggested to me the thought either that there might be two hydrates of platinum chloride present in solution, each possessed of a different diffusibility, or else that some of the lower chloride was present. As the width of the free water margin yielded in the course of an hour or so, in some cases at any rate, depends very much on the strength of the solution, I prepared a solution of ferric chloride of such strength as to yield no free water margin, and then diluted it until a slight margin began to appear. At this point I analysed the solution, which corresponded roughly to the ratio $FeCl_3 : 200H_2O$. On continuing the dilution in geometrical progression by continuously halving its strength, the free water margin rapidly increased in diameter, being always, however, separated from the iron region by a sharp line. When a dilution in the ratio of about $FeCl_3 : 30{,}000H_2O$ is reached, the iron seems to have almost lost its power of diffusing, getting little, if at all, beyond the space wetted by the drop when it first falls upon the paper. Of course, at this dilution it may be said that we are no longer dealing with ferric chloride, but with the products of its dissociation; and this explanation might be adequate but for the fact that an extremely dilute solution of sulphuric acid behaves in the same way. A drop of ferric chloride solution, while spreading upon filter paper, frequently presents an appearance, more or less noticeable, of concentric rings, suggesting, perhaps, the presence of more than one hydrate in solution. Imagining that the presence of hydrates in solution might be in some way or other connected with the formation or diameters of these free water margins, I prepared a solution of potassium bichromate corresponding in strength to Guthrie's cryohydrate, viz., $K_2Cr_2O_7 + 292H_2O$. It readily yielded a margin of water, and it is remarkable that this margin is of about the same width as that yielded either by a saturated, or by a very much more dilute, solution of the salt. I continued the dilution of this solution in geometrical progression, as with ferric chloride, until I brought it to 1/128th of the strength of the cryohydrate, but even this great dilution had little or no effect on the diameter of the free water margin, a result notably differing from that obtained in the case of ferric chloride or sulphuric acid. Copper sulphate solution, on the other hand, undergoes great change in diameter of free water margin on dilution. Hence it may be enquired whether a change in the diameter of free water margin, which must obviously represent a change in the relative velocities of water and the dissolved substance, may not in all cases be an evidence either of dissociation or of changes in the composition of the hydrates existing in solution. Sulphuric acid yields beautifully definite results, the test relied on being that of drying the filter paper at a high temperature, when the portion over which the acid has extended chars. A free water margin begins to be formed at about the strength of 1 part of acid by volume to 200 parts of water; and when a dilution of about 1 in 4000 is reached, the acid (as was the case with ferric chloride) seems to have almost totally lost its power of diffusing, and yields a relatively enormous free water margin. It would be very interesting if it could be shown that this inner zone of non-diffusible sulphuric acid represents a definite hydrate, the diffusibility of which is arrested by its enormous molecular weight, perhaps approaching those of such non-diffusible colloidal substances as the albuminoids; and such a hydrate might possibly be at or near the extreme limit of possible hydration of the acid. With regard to the employment of porous media other than filter paper, I have obtained satisfactory results, both with the mixture of potassic chromate and eosin, and with that of ferric chloride and copper sulphate, by using tubes containing powdered kaolin lightly rammed down, upon the top of which the solution was placed and allowed to soak downwards. I had hoped that this method of separation, or some modification of it, might have proved available for the separation of alkaloids from organic matters of different nature, with a view to their subsequent identification, but have hitherto been very partially successful in this direction.

17. "Note on a meta-azo-compound." By R. Meldola and F. B. Burls.

While azo-compounds of the ortho- and para-series can be represented either as hydrazones or as true azo-compounds by the formulæ—



the azo-derivatives of the meta-series—

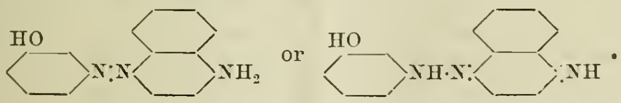


cannot be formulated as hydrazones. We have commenced a series of experiments having for their object the preparation of members of the meta-series, in order to institute a comparison between their properties and those of the ortho- and para-series. It is obvious that a comparative study such as we propose to undertake is calculated to throw light on the question of the constitution of organic colouring matters, as the "quinonoid" bonds are not present in the meta-compounds according to our present method of formulation. As the work must be for the present interrupted, owing to one of us (F. B. B.) having accepted an appointment away from London, we desire to place our results on record in this preliminary communication.

The first compound with which we experimented has not given a decisive result on account of certain practical difficulties which we have not yet succeeded in overcoming. The only satisfactory compounds which are worth studying from the present point of view are evidently those of the type $C_6H_4 \cdot OH \cdot N_2X$ [$OH : N_2X = 1 : 3$], in which X is an *unsubstituted* hydrocarbon radicle. Metamidophenol was diazotised in presence of chlorhydric acid in the usual way and combined with α-naphthylamine, also dissolved in chlorhydric acid. The mixture of the two solutions gradually became of a deep violet-red colour. The azo-compound was finally precipitated by the addition of sodium acetate. The precipitate was collected, washed with water and purified by dissolving it in cold dilute caustic soda, filtering and reprecipitating by acetic acid; it was then digested with dilute ammonia, washed with water and crystallised alternately from dilute alcohol and benzene. Analysis showed that the substance was pure.

Calculated for $HO \cdot C_6H_4 \cdot N_2 \cdot C_{10}H_6 \cdot NH_2$: C, 73·03; H, 4·94; N, 15·96.
Found: C, 73·10 and 73·14; H, 5·56 and 5·54; N, 15·94.

Metaphenolazo-α-naphthylamine may be fairly assumed to have the constitution expressed by the formula



It crystallises in dull, orange-coloured needles fusing at 196°. Its solution in all solvents is orange-coloured and it possesses strong tinctorial power as an orange dye-stuff. It is both acid and basic in properties, readily dissolving in cold aqueous solutions of alkalis, forming orange-coloured liquids and also forming well-defined salts with acids. The solutions of its salts are of a magnificent violet colour. If the hydrazone formula be assigned to the compound, it must be assumed that contact with acids causes its transformation into a compound of the azo-type, as the molecule is strongly basic towards acids and the presence of the amido-group is indicated by the readiness with which the compound can be diazotised. It dissolves in strong sulphuric acid, forming a dull, magenta-red coloured solution, becoming violet on dilution, and on the further addition of water the sulphate separates out in bronzy crystals. Of the salts, the hydrochloride was specially examined. This was prepared by dissolving the base in boiling alcohol and adding strong chlorhydric acid; the colour of the solution changes from orange to violet; the hydrochloride separates out on cooling. The salt forms flat needles having a beautiful bronzy lustre. A specimen allowed to dry in the air for some time and then for a day in a vacuum gave the following results on analysis:—

Calculated for $HO{\cdot}C_6H_4{\cdot}N_2{\cdot}C_{10}H_6{\cdot}NH_2,HCl,H_2O$: Cl, 11·18; N, 13·22; H_2O, 5·67.
Found: Cl, 11·36; N, 13·1; H_2O, 5·73.

The salt does not part with its water at temperatures below 110—120°, and the loss of the water molecule is accompanied by a change in colour from a metallic bronze to a dull green.

In order to further characterise the azo-compound, the acetyl derivative was prepared by boiling a solution of the substance in glacial acetic acid with acetic anhydride till the original violet colour of the solution had changed into orange. On precipitating with water and crystallising the product from dilute alcohol, it was discovered by analysis that it probably consisted of a mixture of a monacetyl with a diacetyl derivative; this was confirmed by the observation that the compound did not completely dissolve in dilute caustic soda, but left a slight residue. Purification was effected by this means, and the dissolved (phenolic) portion, having been precipitated by chlorhydric acid, was crystallised from dilute alcohol and then from dilute acetic acid till the melting point was constant. Beautiful golden scales were thus obtained melting at 232—235° and giving on analysis results agreeing with the formula of a monacetyl derivative—

Calculated: C, 70·81; H, 4·91; N, 1377.
Found: C, 70·53; H, 5·23; N, 13·70.

As this compound is phenolic, it is clear that the acetyl displaces amidic hydrogen and, therefore, that the product has the formula $HO{\cdot}C_6H_4{\cdot}N_2{\cdot}C_{10}H_6{\cdot}NH{\cdot}C_2H_3O$. It dissolves in alkali, forming an orange-coloured solution and possesses strong tinctorial properties. The non-phenolic derivative was not formed in sufficient quantity to enable us to obtain sufficient for complete examination. The melting point, after several crystallisations from dilute alcohol and benzene, was about 226° and the nitrogen approximated in quantity to that required by the diacetyl derivative. The substance forms flat needles of a golden colour and is also an orange colouring-matter. As it is non-phenolic, the hydroxylic hydrogen is probably displaced as represented by the formula $C_2H_3O{\cdot}O{\cdot}C_6H_4{\cdot}N_2{\cdot}C_{10}H_6{\cdot}NH{\cdot}C_2H_3O$.

The main object of the present investigation could not be realised in this case owing to the impossibility of displacing the NH_2 group by H. The method usually adopted in such cases was tried under various conditions, but the product was always a brown, uncrystallisable, resinous substance, which could not be purified by any artifice so as to give satisfactory results on analysis. The substance was phenolic and dissolved in alkali, forming a brown coloured liquid. It may have contained the naphthaleneazometaphenol sought for, but in its impure condition we could draw no conclusion with respect to its colour properties. The experiments are therefore being extended to other compounds of the same series.

18. "The influence of moisture in promoting chemical action. Preliminary note." By H. Brereton Baker, M.A.

It has been shown by the author (*C.S. Trans.*, 1885; *Phil. Trans.*, 1888) that when moisture is removed as completely as possible, certain substances, *e.g.*, carbon, sulphur, phosphorus &c., can be heated in an atmosphere of oxygen without undergoing visible combustion; and he has been engaged during the last two years in continuing the investigation, with the object of ascertaining in what way moisture promotes chemical action. One of the cases which he has studied is the formation of ammonium chloride from ammonia and hydrogen chloride. A difficulty presented itself at the outset in drying ammonia gas, as it is absorbed by phosphoric oxide; this was overcome by drying the gas as completely as possible by freshly ignited lime, after which it was found that phosphoric oxide did not absorb any appreciable quantity. Hydrogen chloride was dried in a similar way by sulphuric acid and finally by a week's contact with phosphoric oxide. On allowing the dried gases to mix, *no ammonium chloride fumes were produced*, and no contraction was indicated by the mercury gauge attached to the apparatus; and it may therefore be concluded that ammonia and hydrogen chloride do not combine when dry.

On introducing a small quantity of moist air, union at once takes place, however. In like manner, sulphur trioxide was found not to unite either with lime or barium monoxide or copper oxide. Furthermore, no brown fumes were produced on mixing dry nitric oxide with dry oxygen. The author is engaged in studying the effect of moisture on various types of chemical action, and he hopes soon to be able to communicate the results to the Society.

*19. "The genesis of new derivatives of camphor containing halogens by the action of heat on sulphonic chlorides." By F. Stanley Kipping, Ph.D., D.Sc., and W. J. Pope.

When the sulphonic chlorides described in a recent paper are heated at temperatures not very far above their melting points, they undergo decomposition, sulphur dioxide being evolved. In the case of camphorsulphonic chloride, chlorocamphor is produced, in accordance with the equation $C_{10}H_{15}O{\cdot}SO_2Cl = C_{10}H_{15}OCl + SO_2$; at the same time a considerable quantity of an oil is formed, the nature of which remains to be determined. This chlorocamphor separates from cold dilute alcohol in arborescent forms; it melts at 137—138°; analyses gave $C = 64{\cdot}26$, $H = 8{\cdot}47$, $Cl = 19{\cdot}35$; $C_{10}H_{15}OCl$ requires $C = 64{\cdot}37$, $H = 8{\cdot}04$, $Cl = 19{\cdot}09$.

By heating chlorocamphorsulphonic chloride, a well-defined dichlorocamphor is obtained, which crystallises from light petroleum in long prisms melting at 118—119°; like the sulphonic chloride from which it is derived, it is dextrorotatory, its specific rotation in chloroform solution being a little higher than that of either of the known dichlorocamphors, namely, $[\alpha]_D = 85°$. Analyses gave $C = 54{\cdot}27$, $H = 6{\cdot}66$, $Cl = 31{\cdot}84$ and $32{\cdot}04$; $C_{10}H_{14}OCl_2$ requires $C = 54{\cdot}34$, $H = 6{\cdot}34$, $Cl = 31{\cdot}99$.

The compound prepared from bromocamphorsulphonic chloride closely resembles dichlorocamphor and crystallises from light petroleum in lustrous prisms melting at 142—143°; like the latter, it has a high specific rotatory power, namely, $[\alpha]_D = 104°$, in chloroform solution.

These three derivatives of camphor appear to be different from any known compounds, and their further study will, it is hoped, throw light on the complex question of isomerism in the camphor series; it is possible that, starting from the corresponding sulphobromides, it will be possible to obtain new bromo-, dibromo- and bromochlorocamphor derivatives, and in this way to establish fresh cases of isomerism; experiments with this object in view are in progress.

Dr. Armstrong informs us that Dr. Wynne and he have noticed in the course of their studies of naphthalene derivatives that a number of sulphochlorides undergo decomposition when heated above their melting points, and that Dr. Wynne has observed that the sulphochlorides of some of the chlorinated toluenes behave similarly. The study of the behaviour of sulphochlorides and allied compounds generally when heated is therefore desirable, and will be carried on in the Central Institution laboratory.

Extra Meeting.—May 5th, 1893.

Dr. Armstrong, President, in the Chair.

HOFMANN MEMORIAL ADDRESSES.

The President, in opening the proceedings, said they were met to do honour to the memory of a man to whom chemists throughout the world, and especially British chemists, are very deeply indebted —probably to a far greater extent than we shall ever be able to realise; a man who on account of his marvellous and manifold gifts will undoubtedly rank among the chemists of the Victorian era as second only to his great master Liebig. Hofmann, even if judged by his published work alone, would take the very highest position; but those who had known the man, however slightly, were aware that he was possessed of rare personal gifts which enabled him to exercise an influence extending far beyond the limits to which any purely scientific worker can attain. It is on this account very difficult to secure a satisfactory presentment of the man and especially of the influence which he directly and indirectly exercised on the development of chemical science and its industrial application. They, however, were fortunate in that they had succeeded in inducing several of the Fellows to co-operate in this arduous task, and although they could not hope to do all that is necessary, the contribution the Society was thus able to make will be exceptionally valuable, as the three gentlemen who would speak of Hofmann that night all had peculiar qualifications.

Lord Playfair, in days long ago, dwelt happily in the verdant and fertile fields of science, and the more often we had evidence of his perennial and vigorous youthfulness the more we must lament that he was ever led away into the tortuous paths of politics; in those almost prehistoric times he was not a mere spectator but an active worker, his name being associated in the records of science with those of the giants Bunsen and Joule. Among others there was a paper by him on "Transformations produced by catalytic bodies," published 45 years ago in the Society's memoirs, which was worthy of perusal even now and which, he ventured to think, displayed greater philosophic grasp of the problem than the more recent essays on the subject. He had been astonished in reading through the early minutes of the Society to see how active an interest the then Dr. Lyon Playfair took in their work: how he was always proposing that something new should be done, and how very frequently his proposals were carried into effect. No one was so well qualified as was Lord Playfair to picture to us the state of affairs chemical at the time of Hofmann's arrival here.

Sir Frederick Abel's qualifications were of a different order—he would speak directly of the man and of the conditions under which he worked at an especially interesting period in his career. He believed that Sir F. Abel's name was first on the list of Hofmann's first set of students, and that he was his first English assistant; he soon became and ever afterwards remained, he might say, his willing slave as well as friend, for Hofmann *had* the power—and hence his marvellous influence—of enslaving all who came under him, and of making them, whether they willed it or no, do the best work they were capable of. Sir Frederick Abel by virtue of his opportunities and his abilities was the man to whom alone we could look on the present occasion. His devotion to the Society was well known to most of the Fellows; but there were few besides the officers who have been concerned with him in the management of its affairs who are fully aware of the extent to which he had served the Society. His presence there to-night was in itself sufficient evidence of the deep interest he still took in their work and of his willingness to sacrifice himself; as all knew, at the present time, he was engaged in the conduct of an enterprise of extreme difficulty and magnitude—more than sufficient to tax the powers of the majority of men, but which appeared in no way to satisfy his insatiable greed of work.

Of Dr. Perkin, who would speak of the outcome of a part of Hofmann's scientific work, it was needless to say much. He was a man of whom it could truly be said that his works are the measure of his worth. If the walls of the room in which they were assembled could speak, it would be of his labours before all others that they would have to tell. The story that he had to relate was of entrancing interest—a true tale of magic, but full of deepest moral.

Lord PLAYFAIR said that, although, when he was at Giessen, Hofmann was about two years his senior in age, Hofmann was studying mathematics and physics, and although he mixed with the active workers in Liebig's laboratory, he was not one of the body, and did not begin to work there until some time afterwards; it was originally intended that he should devote himself to philology and law, of which he was during some time a student. Referring to his remarkable linguistic powers, he said he had heard him make speeches in several languages, and especially remembered one occasion when, in 1867, at a memorable banquet given by the French chemists to those of foreign countries, Hofmann proposed the health of their hosts in a capital French speech.

He then spoke of the position of chemistry in England prior to Hofmann's arrival. Both in the last and the early part of the present century, England was not wanting in great chemical investigators. Among others, Lord Playfair referred to Dalton, incidentally mentioning that he could never forget seeing his venerable figure, supported on the arm of Dr. Joule, come daily to hear him lecture at Manchester on organic chemistry. Except Graham, under whom the speaker studied in Glasgow in 1835–36, following him to London as private laboratory assistant, no one, however, had thought of opening his laboratory to students. Graham's example, however, spead, and several colleges, and even the universities, slowly adopted the view that laboratories were necessary to teach and train the chemists of the future; but all who desired to study organic chemistry flocked to Giessen, and returning from there acted as missionaries in spreading a knowledge of the new organic chemistry. An extraordinary influence was exercised by the publication, in 1840, of Liebig's celebrated work, *Chemistry of Agriculture and Physiology*, which was heightened by a triumphal tour, made two years later, by Liebig, through this country, in which he was personally conducted by the speaker. The immediate effect of Liebig's tour was to make chemistry a popular science, and to induce colleges to open laboratories, and hence it was that the Royal College of Chemistry was founded in 1845. Two wise men were mainly instrumental in its establishment —the Prince Consort and the Queen's physician, Sir James Clark. They saw that all the chemical laboratories in existence in this country were mere accessories or subordinate to professional training, the students entering them rarely wishing to become chemists; and they desired to found a college where chemistry might be studied for its own sake. A college of this kind without endowments could not have been created unless a strong popular feeling had arisen, such as Liebig's work had promoted.

After referring to Hofmann's appointment, his remarkable lucidity, and his marvellous powers of exciting enthusiasm, Lord Playfair spoke of the early success of the College of Chemistry, and then proceeded to explain how it was that it so soon ceased to exist as an independent institution. Every landowner had thought that Liebig's book was to be his salvation, and when it was found not to produce the expected results, popular belief in chemistry declined, and the support accorded to the college gradually dwindled. At this time the speaker resigned his professorship at the School of Mines, and Hofmann succeeded him, carrying with him the College of Chemistry, which then ceased to be an independent institution: the change was inevitable under the circumstances, but it was not good either for the college or chemical science. No doubt Hofmann felt this, and was affected by it when he was offered a professorship in the Berlin University, where he went in 1864.

Lord Playfair concluded his address by expressing the hope that he might live to see a new college or institute arise like a phœnix from the ashes of the old one, perhaps in connection with higher university teaching in London, as a supplement to, and not in competition with, existing laboratories, in which chemistry might be taught as an independent subject.

Sir FREDERICK ABEL, at the outset of his address, referred to the commencement of his own career as a chemist as an illustration of the difficulties attending the attempts of young beginners with limited resources to acquire a knowledge of practical and analytical chemistry, with a view of adopting the science as a profession, half a century ago. In the autumn of 1844, he had entered the laboratory of the Royal Polytechnic Institution, only to find that the sole means of acquiring some practical knowledge consisted in plodding unaided through Brande's Manual, endeavouring to acquire experimental skill by preparing the elements and their compounds according to the directions therein given, and to become acquainted with analysis by following Andrew Parnell's tables. Several other young chemists, who afterwards became prominent pupils of Hofmann, were in a similar position at that time, and so, when the temporary laboratories of the new college were opened in the autumn of 1845, there was a small band of aspirants impatiently waiting to avail themselves of the benefits of the system of instruction which had already acquired so high a reputation on the Continent.

Sir Frederick then recited the history of the efforts made in this country as early as 1843 to establish an institution where the systematic study of chemistry as a profession in itself could be pursued, referring to the prominent part taken in the matter by Dr. John Gardner, the translator of Liebig's Letters on Chemistry, and Mr. J. Lloyd Bullock, one of Liebig's earlier pupils, and pointing out how very nearly a National Practical School of Chemistry became associated with the Royal Institution. After the failure of the negotiations with the Royal Institution, the agitation was continued, and ultimately, at a public meeting at the temporary offices of the College of Chemistry on July 29, 1845, a definite form was given to the proposed Institution, and a Council and Executive Officers were appointed, after which the first all-important subject to receive anxious consideration was the appointment of a Professor. The circumstances attending Hofmann's appointment were next referred to.

Temporary laboratories were fitted up in George Street. Twenty-six students entered in the first session, among whom were F. A. Abel, C. L. Bloxam, Warren De la Rue, R. Galloway, Henry How, E. C. Nicholson and Thomas Rowney.

Hofmann's complete sway over his pupils, said Sir F. Abel, was at once secured by his indomitable perseverance and inexhaustible patience with the dullest, his earnestness of manner, his clearness of exposition, rendered additionally attractive by an inherent quaintness and a power of happily rendering German expressions into graphic English. Those first two sessions of the College, in the scantily equipped laboratories, with make-shift contrivances of the crudest character and an utter absence of any convenience for conducting investigations, must have been a sore trial of patience and powers of endurance to the impetuous young teacher, and to the enthusiastic worker, whose only recreation was the pursuit of original research When to these circumstances is added the mental strain involved in the almost continuous pursuit of instruction and discussion in a foreign language, for at least eight hours daily, to say nothing of continued anxious consultations with the Council and officials of the College regarding ways and means; the heavy work connected with the erection and equipment of the permanent laboratories; the grappling with the problems of maintaining and fostering public interest in the Institution, and of keeping current expenses within very moderate bounds: it is self-evident that no small moral courage and powers of endurance were needed for the successful accomplishment of these duties; for the maintenance of the confident and apparently light-hearted demeanour, and of the power of instilling into others confidence of future success, which were peculiarly characteristic of Hofmann in those days of supreme difficulty. But these very characteristics, added to his genial and charming manner, high flow of spirits and originality in conversation and correspondence, secured to him devoted friends, not merely among colleagues and pupils, but in whichever direction social intercourse was opened up to him. Just as his earnestness of purpose and enthusiasm kindled corresponding qualities in a large proportion of his pupils, so also his sanguine temperament and airy treatment of difficulties maintained, among many of the early friends and important patrons of the struggling Institution, a steadfastness of purpose which otherwise would doubtless have speedily waned.

Hofmann's method of teaching and his powers as a lecturer were next alluded to.

Thirty-seven students entered in the second session, making sixty-three in all, and the laboratories became inconveniently crowded. The third session was commenced in the new laboratories in Oxford

Street in October, 1846. These included a small private laboratory for the Professor, and here Hofmann at once resumed research work, Nicholson acting as his assistant.

There is but one opinion among those who can appreciate the stupendous difficulty of the task so brilliantly accomplished by Hofmann, in placing the College of Chemistry upon a sure foundation, and in securing to it, within a very few years, a high position among the chemical schools of Europe—that his success was ascribable to the possession of a happy and rare combination of the highest talents as a teacher with exceptional powers as an investigator, inexhaustible industry and energy, and an enthusiasm not to be subdued by any obstacles—a characteristic quality possessed in the highest degree by his great master, Liebig.

The severity of work and many-sided training which those who assisted Hofmann in the early days of the College of Chemistry was illustrated by an account of Sir F. Abel's experience during five years as an assistant.

Sir F. Abel then referred to the more prominent pupils of Hofmann; to the character of the researches carried on in the College; to Hofmann's faculty of gauging the abilities and special qualifications of those who worked under him, and his power of directing and stimulating them; to his marvellous literary and linguistic skill; and to the ease with which he made friends. The pleasure with which he always referred to his career in London was illustrated by a letter addressed by Hofmann to the Prince of Wales, who, as President of the Society of Arts, wrote to him, in 1882, congratulating him on being the recipient of the Albert medal.

Dr. PERKIN said that he was charged with the duty of giving an account of the rise and progress of the coal-tar colour industry, with which Hofmann's name was so inseparably connected, which he had been requested to make to a large extent autobiographical.

Aniline was Hofmann's first love, the subject of his first research, and he was the first to recognise the presence of benzene in coal tar; in 1845, at his instigation, Charles Mansfield undertook the investigation of the coal-tar light oils, in the course of which he sacrificed his life, while obtaining results of the utmost value, both scientifically and technically. Dr. Perkin said that he entered as a student under Hofmann when in his 15th year, at the time when the Royal College of Chemistry became a part of the School of Mines: he soon got through the ordinary analytical course, and began to work at research—the problem which he was set by Hofmann to solve being to prepare a base from the hydrocarbon anthracene. Although the desired base was not obtained, the compound now known as anthraquinone was prepared, and also chloro- and bromo-derivatives of anthracene, but the results of the analyses were unintelligible, and it never occurred to them to doubt the correctness of Dumas and Laurent's formula for anthracene, $C_{15}H_{12}$. The experience thus gained, however, proved of great value later on.

When in his 17th year, he was promoted to the position of an assistant in the Research Laboratory, and as he had necessarily little time for private work in the day time, a room at home was roughly fitted up where he was able to work in the evenings and during vacations. Here a research was carried on jointly with Mr. Church, also an assistant in the Research Laboratory at the College, on some colouring matters derived from dinitrobenzene and dinitronaphthalene, in the course of which amidoazonaphthalene was prepared, which appears to have been the first compound obtained of the diazo-class shown to possess dyeing powers.

At about this time the artificial formation of natural organic substances attracted much attention, and Hofmann specially referred to the importance of preparing quinine in his report of the Royal College of Chemistry, pointing out that, judging from its composition, it might be a derivative of naphthylamine. Dr. Perkin said that as a young chemist he was ambitious to work on the subject and, probably fired by Hofmann's remarks, began to think how quinine might be formed: it occurred to him that it might be produced by oxidising allyltoluidine, and experiments in this direction were accordingly made—needless to say, to no purpose, but the results led him to experiment on the oxidation of salts of aniline, and on using potassium bichromate a product was obtained containing among other substances the colouring matter afterwards known as aniline purple, Tyrian purple or mauve. These experiments were made at home in the Easter vacation of 1856. In the summer vacation the preparation of the colouring matter was undertaken on a small technical scale in the back garden at home, and ultimately the process was patented on August 26, 1856. Not long afterwards, in conjunction with his father and brother, he commenced the manufacture of the dye. The extraordinary difficulties to be overcome were then referred to; not only had all the mechanical appliances to be devised, but at this time benzene was made in but small quantities and nitric acid of sufficient strength could not be procured commercially; moreover, methods of dyeing with the new colour had to be worked out.

Dr. Perkin then referred to the discovery of fuchsine (rosaniline) in France, and explained how Messrs. Simpson, Maule and Nicholson, originally manufacturers of fine chemicals, began its manufacture. Through Nicholson, Hofmann at this time exercised an all-important influence on the industry. Hofmann had always insisted on the absolute necessity of obtaining products in as nearly pure a condition as possible, and had thoroughly imbued Nicholson, who had carried out several investigations under him, with this idea; owing to Nicholson's skill, his firm soon succeeded in supplying fuchsine in a crystallised condition, and the example thus set has been of the greatest value.

Hofmann's own early investigations of rosaniline and its various derivatives were then referred to, and, after sketching the further developments of the industry, Dr. Perkin drew attention to Hofmann's various researches bearing on derivatives of coal-tar products.

In the latter part of his address he more briefly referred to the rise of the alizarin industry, pointing out that, although Hofmann had taken no part in this, it was undoubtedly the fact that his early introduction to anthracene, which he owed to Hofmann, was the cause of his becoming interested in the subject immediately Graebe and Liebermann's great discovery was announced. As in the case of the aniline colour industry, so in that of the alizarin industry, all the necessary machinery had to be devised, and many of the materials required had to be specially prepared for the purpose.

Hofmann's researches in connection with coal-tar colouring matters extended over a period of 25 years, from 1862 to 1887, and through these and the training which he imparted to those of his students who took part in the industry he exercised an influence unique in the history of modern industrial enterprise.

ADDITIONS TO THE LIBRARY.

I. *Donations.*

Annual Report of the U.S.A. National Board of Health, 1882. Washington 1883. From the Secretary of the Treasury, U.S.A.

U.S. Geographical and Geological Survey of the Rocky Mountain Region; Contributions to North American Ethnology. Vol. VII. A Dakota-English Dictionary, by S. R. Riggs; edited by J. O. Dorsey. Washington 1890. From the Director of the Survey.

Smithsonian Institution: Seventh Annual Report of the Bureau of Ethnology, 1885-6, by J. W. Powell. From the Institution.

II. *By Purchase.*

Carl Wilhelm Scheele: Nachgelassene Briefe und Aufzeichnungen, herausgegeben von A. E. Nordenskiöld. Stockholm 1892.

A Dictionary of Applied Chemistry, by T. E. Thorpe. Vol. III London 1893.

RESEARCH FUND.

A meeting of the Research Fund Committee will be held in June. Fellows desiring grants are requested to make application before June 10th.

NOTICE TO AUTHORS OF PAPERS.

Authors are particularly requested to send their papers to the Secretaries, at Burlington House, *not later than the Monday previous to the meeting at which they are to be read.*

In all cases an abstract of each paper should be supplied for insertion in the "Proceedings."

HARRISON AND SONS, PRINTERS IN ORDINARY TO HER MAJESTY, ST. MARTIN'S LANE.

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PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

No. 125. Session 1893-94.

May 18th, 1893. Dr. Armstrong, President, in the Chair.

Mr. H. A. D. Jowett was formally admitted a Fellow of the Society.

Certificates were read for the first time in favour of Messrs. S. W. M. Davy, Sharrow View, Sharrow, Sheffield; James John Howitt, Dunley, Toft Road, Knutsford; John Walter Leather, 15, Bradgate Road, Catford, S.E.; K. P. McElroy, 1,412, Sixteenth Street, Washington, U.S.A.; John Watson Napier, Minto House, Edinburgh; Claude Theodore James Vautin, 10, Hanover Square, London; Edward Augustus Warmington, 266, Castle Street, Dudley.

Of the following papers those marked * were read:—

*20. "Studies on the formation of ozone. II." By W. A. Shenstone and Martin Priest.

The authors have submitted a known volume of oxygen confined in an ozone generator of the Brodie pattern to the influence of discharges produced by varying differences of potential, and have determined the amount of ozone produced by observing the change in volume by means of a mercury manometer. A full description is given of the contact breaker used, of the means adopted to measure the differences of potential, to prevent the ozone coming into contact with the mercury, &c.; in some of the experiments the discharge from an induction coil, in others that from an influence machine, was used. The following conclusions are drawn:—

1. It is possible to obtain very fairly concordant results.
2. Provided that the path of the discharge be not too short at any

point in the generator, the maximum proportion of ozone that can be produced at a given temperature and pressure is nearly independent of the difference of potential employed, provided that this be between the limits of 33 and 69 C.G.S. (electrostatic) units.

3. If the path of the discharge be very short at any point in the generator, the maximum proportion of ozone that can be obtained has an inverse relation to the differences of potential employed.

4. The rapidity with which oxygen is converted into ozone in a given ozone generator, and under given conditions of temperature and pressure, is greater when great than when small differences of potential are employed, or, in other words, a given percentage of ozone can be obtained more quickly by employing a high difference of potential than by means of a lower one.

5. The maximum proportion of ozone that is obtained in a given generator, at given temperature and pressure, is less when the number of discharges in unit of time is very great than when it is more moderate.

6. The highest proportions of ozone can be obtained (at given temperature and pressure, and if a given difference of potential be employed) by using a generator made of very thin glass and in which the inner tube fits into the outer tube rather closely, but such a generator acts very slowly if the mingling of its contents depend upon diffusion.

7. A greater proportion of oxygen can be converted into ozone in a given generator by means of a given difference of potential, the gas being maintained at a given temperature and pressure, by the action of an induction coil than by means of a "Wimshurst" or "Voss" machine.

The authors conclude from their results that the silent discharge acts by decomposing oxygen molecules into their atoms, which, subsequently re-combine to a greater or less extent (according to the temperature and pressure) to form the triatomic molecules of ozone; and that ozone is not formed by the direct action of the discharge.

Discussion.

Professor McLeod referred to the heating effect of the discharge, and asked whether it had been noticed that a rise of temperature took place in the inner vessel of the generator which might account for the decomposition. He drew attention to the possibility of producing ozone in considerable quantity by subjecting oxygen under pressure to the influence of the discharge in a tube one end of which was at a low temperature: unfortunately the tendency of ozone to explode when in the liquid condition appeared to be a barrier to the successful application of this method.

Professor Ramsay commented on the fact that the authors had paid attention only to the influence of difference of potential, and had not taken into account what was probably of more importance, viz., the quantity of electricity in the discharge.

Mr. Crookes concurred in Professor Ramsay's criticism, and said that perhaps the difference observed in the case of the coil and influence machine might be ascribable to this, as the coil would afford a larger quantity of electricity; and that a rapid discharge would also afford a smaller quantity of electricity than a slow one. Locally the temperature might be very high in such tubes. He then referred to the difficulty he had frequently met with in causing a discharge to pass in "Tesla" tubes: a tube through which no discharge would pass during several minutes would suddenly become luminous, but only when charged dangerously near to the breaking point.

Mr. G. N. Huntly asked whether Mr. Shenstone intended to study the effect of temperature on the yield of ozone; as it was a substance in the formation of which heat was absorbed, its stability should reach a maximum at a temperature fixed by its physical constants, and either above or below this temperature the yield of ozone should fall off. In connection with this, the production of ozone at 1200—1300° C., observed by Troost and Hautefeuille, required confirmation.

The President regretted that no electricians were present to discuss the arrangements adopted by the authors. Professor J. J Thomson, he knew, held the view that the electric discharge in gases was of the nature of chemical action. Personally he was not satisfied with the evidence adduced by Cundall and Shenstone that only oxygen was concerned in the production of ozone; he was of opinion that it would eventually have to be admitted that the formation of ozone was the outcome of an electrolytic change, in which probably conducting moisture was concerned, somewhat as expressed by the symbols

$$\begin{matrix} O_2\ OH_2 \\ O_2^{\cdot}\ OH_2' \end{matrix}\ O_2 \leftrightarrows \begin{matrix} O_3\ H_2O \\ O_3'\ H_2O^{\cdot} \end{matrix}$$

Mr. Shenstone, in reply, said that the electricity does not flow directly from the induction coil, or machine, into the ozone generator. It acts inductively; the ozone generator being a sort of condenser with a compound dielectric consisting of two layers of glass with a layer of oxygen between them. The discharge inside the ozone generator depends on a surface electrification set up on the glass. The "quantity" of electricity which passes through the oxygen in a given ozone generator at each discharge depends on the difference of potential thus set up, and this in its turn depends on the difference of potential of the inducing charge at the two electrodes of the generator. Therefore when the difference of potential of the inducing charge is increased, the quantity of electricity which takes part in a discharge is increased, and *vice versâ*, and we are in fact studying the effect of different "quantities" of electricity on the gas, and we know when we increase or decrease the quantity.

With regard to the suggestion that the greater "quantity" of the current of a coil may explain some of the phenomena, it would seem that this is not likely to influence the inductive effect of a charge at a given difference of potential. It would simply make it possible to bring up the charge to the desired difference of potential somewhat more quickly by means of a coil than by means of a machine.

They had not observed any extra heating of the acid in the inner tube of the generator, but rather the contrary. Referring to Mr. Crookes' remarks, he said that they had sometimes observed that the production of ozone did not set in until after some time.

*21. "The relative strengths or 'avidities' of some compounds of weak acid character." By John Shields, D.Sc., Ph.D.

The author has calculated the relative strengths of a number of compounds of weak acid character from the rate at which salt solutions hydrolyse ethylic acetate (*Phil. Mag.* [5], **35**, 365).

The comparison has been made in deci-normal solution, the "dissociation ratio" being taken as the measure of relative strength or "avidity," and in order to obtain a better idea of their relative strengths the compounds examined have been compared with some of the stronger acids taken from Ostwald's tables. The results are contained in the following table, from which it will be seen that in deci-normal solution, hydrogen chloride, for example, is about 100,000 times stronger than phenol.

Hydrogen chloride	100
Trichloracetic acid	68
Dichloracetic „	33
Monochloracetic acid	4·3
Acetic „	0·35
Biboric „	0·0057
Hydrogen cyanide..................	0·0026
Phenol	0·00094
Carbonic acid....................	0·00091

*22. "The boiling points of homologous compounds. Part I. Simple and mixed ethers." By James Walker, Ph.D., D.Sc.

The author finds that the boiling points of many homologous series may be expressed by means of the relation $T = aM^b$, where T is the boiling point on the absolute scale, M the molecular weight, and a and b constants which have values peculiar to each series. He applies the formula to the ethers prepared and investigated by Dobriner (*Annalen*, **243**, 1) and Pinette (*Annalen*, **243**, 33). The difference between the calculated and observed values is generally considerably less than a degree. The following rule is a deduction from the formula:—The logarithm of the ratio of the absolute boiling points of any two members of a homologous series, divided by the logarithm of the ratio of their molecular weights, is constant.

23. "The conditions determinative of chemical change." By Henry E. Armstrong.

Notwithstanding the large amount of evidence now placed on record that substances commonly supposed to be capable of directly interacting do so only in the presence of at least one other substance, chemists do not appear to have arrived at any clear and consistent understanding of the conditions determinative of chemical change: as each fresh case is recorded, we continue to express surprise, overlooking the fact that Faraday, in his early "Experimental Researches in Electricity," clearly foresaw what the conditions were, and that but a slight extension of his generalisations is needed to frame a comprehensive theory. The subject is of such importance that it appears to me desirable to discuss the bearing of recent observations, especially as they to some extent necessitate the modification of views that I have expressed elsewhere, and in order to attract the attention of physicists, to whom we must now look for guidance in these matters.

Eight years ago, in the course of the discussion on Mr. H. B. Baker's communication on "Combustion in dried gases" (these Proceedings, 1885, 40), I defined chemical action as *reversed electrolysis:* in other words, in order that chemical action may take place, it is essential that the system operated on comprise an electrolyte. I then pointed out that as neither hydrogen nor oxygen was an electrolyte, a mixture of only these two gases should not be explosive; and, moreover, that as water was not an electrolyte, and it was scarcely probable that water and oxygen or hydrogen would form an electrolyte, it was difficult to understand how the presence of water pure and simple should be of influence in the case of a mixture of hydrogen and oxygen. This forecast has since been verified, the remarkable series of experiments carried out by V. Meyer in conjunction with Krause and Askenasy having clearly demonstrated that the formation of water from hydrogen and oxygen takes place at an irregular rate, and is, therefore, dependent on the presence of a something other than water—I imagine an acid impurity. But this is a consideration which has not yet received the proper attention, and it is, therefore, desirable to emphasise its importance by reference to other cases. Mr. Baker's recent preliminary note on the influence of moisture in promoting chemical action (*ante*, p. 229) affords several interesting examples:—Thus, he states that neither does hydrogen chloride combine with ammonia nor is nitric oxide oxidised by oxygen if moisture be excluded. In the former case, the addition of water should suffice to determine the combination, as water and hydrogen chloride together form a "composite electrolyte" (*cf. Roy. Soc. Proc.*, 1886, No. 243, p. 268); as neither nitric oxide nor oxygen, however, forms a composite electrolyte with water, in this case water alone should not determine the occurrence of change; but if by the introduction of a trace of "impurity" in addition to water the presence of a composite electrolyte were secured (however high its resistance, owing to the smallness of the amount of "impurity"), action would set in, and when once commenced would proceed at an increasing rate, as nitric acid would be formed and the resistance of the electrolyte would consequently diminish. On this account it will be a task of exceeding difficulty to experimentally demonstrate that nitric oxide and oxygen are inactive in presence of water alone; but there can be no doubt that such must eventually be admitted to be the case, provided always that it is permissible to extrapolate Kohlrausch's observations and to conclude from them that *pure* water is a dielectric. The gradual increase in the rate of change here contemplated corresponds to the period of induction observed by Bunsen and Roscoe in their observations on the interaction of chlorine and hydrogen; the statement recently made by Bodenstein and V. Meyer (*Berichte*, 1893, 1146) that a mixture of chlorine and hydrogen behaves irregularly on exposure to light is a valuable confirmation of Pringsheim's observations, and there is now no room for doubt that *pure* chlorine and hydrogen would be incapable of interacting. That no such irregularity is observed on heating iodine with hydrogen is not surprising, as hydrogen iodide would be formed from the very outset and the electrolyte present would exert a minimum resistance almost at once. There is, however, a significant difference in the behaviour of the two mixtures, as hydrogen chloride should behave as hydrogen iodide, so that the problem is but incompletely solved: it may be that the one mixture was more nearly pure than the other, or it may be that the formation of hydrogen chloride from hydrogen and chlorine, under the influence of light, is dependent on the presence of some particular substance, together with water, and does not take place under the influence of any substance capable of forming a composite electrolyte with water; probably, however, the difference observed is chiefly due to the fact that only one of the actions is reversible under the conditions prevailing in the experiments.

Lastly, attention may be directed to the formation of sulphuric oxide from sulphurous oxide and oxygen, which is readily effected in presence of a catalyst, such as finely divided platinum; it cannot be supposed that the mere presence of platinum would condition the occurrence of change, and doubtless moisture is also necessary, the platinum or other catalyst but serving to promote the oxidation of the sulphurous oxide at a temperature considerably below that at which sulphuric oxide decomposes when heated. The action of surfaces generally may well be of this character, and the converse influence they so frequently exercise is probably an effect of the same order.

I have elsewhere raised the question whether there may not be a difference between actions taking place under the influence of low and of high electromotive forces—whether water, *per se*, may not be an electrolyte towards high, although not towards low, forces in the case of high temperature changes, or those brought about under the influence of the electric spark, for example. More attentive consideration of the subject has led me to think that this is not the case, and that we must treat high temperature changes such as occur and are involved in gaseous explosions in the same way as those occurring under ordinary conditions and at low temperatures. From this point of view, Mr. Baker's statement that ammonia and hydrogen chloride do not combine is of extreme importance; the formation of ammonium chloride from these two compounds apparently involves no interchange, but a mere combination of two substances each endowed with considerable "residual affinity," and there is no reason why a distinction should be drawn between such a case and that afforded by, say, *atoms of hydrogen and oxygen*, the difference being, it would seem, one of degree only: in fact, I am no longer inclined to believe that atoms are capable of directly uniting. In all cases at least one function of the (composite) electrolyte would appear to be that of providing the necessary "mechanism" whereby the degradation or discharge of the energy is effected. If this argument be sound, its logical extension involves the conclusion that *pure* gases should be dielectrics, *i.e.*, that the passage of an electric discharge through a gas like that of an explosive wave through, say, a mixture of hydrogen and oxygen, can only take place if an electrolyte be present. Hitherto but little attention has been paid to the electric discharge in gases which have been highly purified. The peculiar behaviour of Tesla tubes referred to by Mr. Crookes in the discussion on Mr. Shenstone's paper on the formation of ozone is, perhaps, explicable from this point of view—it may be that the atmosphere within the tube does not become conducting until sufficient moisture and "impurity" have been projected from its sides. It is conceivable that a similar explanation may hold good in the case of Professor Schuster's observation, that it is possible to urge a current of low electromotive force across a gas subjected to a high electromotive force in itself insufficient to cause a discharge in the gas; the atomic dissociation hypothesis put forward in explanation of the phenomenon does not appear to me to be sufficient.

Finally, the question arises, Can no line be drawn; are no two pure substances capable of combining or interacting:—For example, water and sulphuric anhydride? There is little to guide us here, but it seems not unlikely that water has special properties which enable it to act directly; moreover—perhaps because—in such cases composite electrolytes would result. Ammonium chloride, so long as it remains solid, is clearly a compound of a different order, and it may well be that compounds of this type are in no case directly obtainable from their constituents, because, under the conditions under which they are formed, they cannot behave as electrolytes.

Apparently, in all cases in which molecular aggregates are formed—as in the case of solutions—we are dealing with dissociable and dissociating systems, and it is not improbable that we may ultimately find an explanation of the mechanism of such changes in this fact.

At present there is no information forthcoming whether simple electrolytes, such as fused silver chloride, for example, will condition chemical change in the way that water does—whether, for instance, silver chloride will condition the formation of hydrogen chloride from chlorine and hydrogen, so that a gas battery might be constructed of these three substances.

24. "The nature of depolarisers." By Henry E. Armstrong.

When an electric current is passed between plates of platinum through a solution of sulphuric acid, the hydrogen and oxygen are partly retained at the surfaces—and apparently also within the plates—and under these conditions are capable of interacting, as in the well-known Grove gas battery: so that in so far as the "gases" thus circumstanced are concerned the change may be expressed by a reversible equation. This reversal constitutes the well known phenomenon termed polarisation by physicists.

Reversal owing to the retention of hydrogen in circuit is promoted to different extents by different metals—hence apparently the varying electromotive forces of single fluid cells containing different negative plates; and when the pressure is sufficient to retain the whole of the hydrogen at the plate, it becomes total—hence it is, for example, that zinc does not dissolve in sulphuric acid under great pressure.

Various substances known generally as depolarisers are used to prevent the accumulation of products of electrolysis and the consequent reversal of the action—such as copper sulphate in the case of the Daniell cell and "nitric acid" in the case of the Grove and Bunsen cells; but whereas the action of copper sulphate is easy to understand, that of "nitric acid" offers many difficulties. As the heat of dissolution of copper in dilute sulphuric acid is a negative value (about 12,000 units), the displacement of copper by hydrogen—*i.e.*, the heat of dissolution of hydrogen in copper sulphate—is a positive value, so that not only does the presence of the copper sulphate prevent the accumulation of hydrogen, but in removing hydrogen it also serves to increase the electromotive force of the cell from about 37/46ths to about 50/46ths of a volt. The principle underlying this is extensible even to cases in which one part of the cumulative effect of the cycle of change is a negative value. Thus, although copper has a negative heat of dissolution, it will readily dissolve in dilute sulphuric acid if it be used in place of zinc in a Grove cell, the negative heat of dissolution of copper being more than compensated for by the positive heat of dissolution of hydrogen in "nitric acid"; and it is well known that copper dissolves in many weak acids in presence of oxygen. It is easy to understand how oxygen acts in such cases, but the facts show that the effect produced by "nitric acid" is not so readily interpreted, and their consideration raises important questions of general application.

Russell and Lapraik have shown that when "nitric acid" is freed from nitrous compounds it does not dissolve silver, but that action sets in when a trace of nitric oxide is introduced, and continues with increasing rapidity as the quantity of the nitrous compound—a necessary product of the action—increases; Veley's later experiments have shown that the same is true of copper, without, however, affording any further explanation of the phenomena. Although it is not to be expected that such metals would dissolve in nitric acid even when coupled with a relatively electronegative conductor, as they have negative heats of dissolution, yet if the acid also acted as depolariser a cycle might be formed in which sufficient energy would be developed to condition change: it therefore follows that in such cases *nitric acid* does not act as the depolariser in accordance with the equation: $2Ag + 2NO_3H + ONO_2H = 2AgNO_3 + H_2O + NO_2H$, and that in point of fact the nitrous compound is the depolariser, although the nitric acid is the actual solvent of the metal, the hydrogen of the acid being virtually directly displaced by the metal with the assistance, however, of the current energy derived from its own oxidation by the nitrous compound.

But what interpretation is to be given of the behaviour of more active metals, such as zinc, magnesium, &c., which have positive heats of dissolution, and, therefore, are capable of dissolving in the pure dilute acid if coupled with a relatively negative conductor; does nitric acid in their case directly act as depolariser? If it be capable of thus acting, such metals even when uncoupled should dissolve in the pure diluted acid. It is noteworthy that when such metals are dissolved in nitric acid hydrogen is sometimes evolved. It has been suggested that this hydrogen is derived from the interaction of the metal and water, but I cannot now regard this as a probable explanation; its production serves rather to suggest a deficiency of the depolarising agent, which cannot well occur if nitric acid be the depolariser. Indeed, if nitric acid be regarded as directly active, it is remarkable that in presence of the large excess of the acid which is always present any hydrogen should escape; and also that the reduction should extend so far at it often does, and not extend merely to the formation of nitrous acid. If, however, the acid be incapable of directly acting as depolariser, and a nitrous compound be the initially active depolarising agent, it is no longer surprising that owing to the nitrous compound suffering further reduction it should be deficient in parts of the circuit, and that consequently hydrogen should escape. Why the reduction should extend so much further when metals having positive heats of dissolution are used, however, still requires elucidation.

In the case of sulphuric acid, whatever metals be dissolved in the *diluted* acid, no reduction takes place; and it is only when the concentrated and more or less heated acid is used that sulphurous oxide and other reduction products are obtained. It appears not improbable that reduction only takes place under conditions under which the presence of sulphuric *oxide* is possible, *i.e.*, that depolarisation is effected by sulphuric *oxide* and never by sulphuric *acid*, although this latter may be regarded as the actual solvent of the metal. There is at present no evidence forthcoming to show that nitric acid can dissociate into the anhydride and water, and even if such a change took place in concentrated solutions, there is no reason to assume that it can also take place in dilute solutions, and that this is the explanation of the difference between nitric and sulphuric acids. It is well known, however, that nitric acid is resolved with extreme facility into nitrogen dioxide, water and oxygen, and that it is excessively sensitive to the action of nitric oxide—a trace of nitric acid would therefore exercise a fermentative action and condition, the formation, it may be, of nitrous acid, or—as there is no evidence compelling us to suppose that the compound represented by the formula HNO_2 exists—it may be of nitrogen dioxide. In this latter case, solutions of nitric acid would resemble concentrated sulphuric acid in containing a reducible oxide, and it may be that their depolarising action is initially exerted through such an oxide alone.

To arrive at a clear conception of the function of acids in dissolving metals, and of the nature of depolarising agents, it would, therefore, appear to be necessary to take into account many circumstances to which hitherto but little attention has been paid.

RESEARCH FUND.

A meeting of the Research Fund Committee will be held in June. Fellows desiring grants are requested to make application before June 10th.

NOTICE TO AUTHORS OF PAPERS.

Authors are particularly requested to send their papers to the Secretaries, at Burlington House, *not later than the Monday previous to the meeting at which they are to be read.*

In all cases an abstract of each paper should be supplied for insertion in the "Proceedings."

CERTIFICATES OF CANDIDATES FOR ELECTION AT THE NEXT BALLOT.

N.B.—The names of those who sign from "General Knowledge" are printed in *italics.*

The following Candidates will be balloted for on 15th June, 1893:—

Bailey, Henry,

18, Lavender Sweep, London, S.W.

Analytical Chemist and Assayer. Four years Assistant to the Public Analyst of Cornwall. Assisted in the experimental work for the Messrs. Beringer's book on "Assaying," as mentioned in preface. Some time Lecturer on Chemistry and Metallurgy at Penzance Science School. At present Chemist to the Rio Tinto Copper Co., Ltd.

C. Beringer. J. J. Beringer.
John Gill. P. Gerald Sanford.
William Bate.

Bateman, John,

Saltney, near Chester.

Manager of Candle Works and Paraffin Refinery, Sulphuric, Nitric and Nitro-naphthalene Works. 20 years' experience in manufacture of Candles and Paraffin refining. "Sulphuric acid Works Chemist." Honours, South Kensington S. & A., Inorganic and Organic.

W. F. Love. John Bairstow.
G. Watenny W. Webster. *A. J. Greenaway.*
J. Carter Bell.

Berridge, Douglas S. P., B.A. Oxon.,

Malvern College.

Schoolmaster. Studied Science at Technical Schools, Linisted, and at University of Oxford, took 2nd class Honours degree in Natural Science at latter; at present Science Master, Malvern College; engaged now, as for some time past, in studying Action of Light on Metallic Iodides.

W. W. Fisher. V. H. Veley. J. E. Marsh.
John Watts. H. Brereton Baker.

Cahill, Robert S.,

90, Park Lane. Norwich.

Science Master of the Duke Street Higher Grade Organised Science School. I have at present over 180 students in Theoretical and Practical Chemistry, including Advanced and Honours pupils, and have taught science work for 10 years.

Francis Sutton. — Edward J. Caley.
F. Napier Sutton. — *John R. Skelton.*
William Jago. — *John J. Pilley.*

Coste, John Henry,

69, Goswell Road, E.C.

Analytical Chemist. Joint author (Meldola and Coste: "Benzyl Derivatives of the Phenylenediamines," *J. Chem. Soc.*, 1889, 590), late Student and Senior Student Chemical Department, Finsbury Technical College, Assistant in Laboratory of Royal Agricultural Society of England.

J. Augustus Voelcker. — E. W. Voelcker.
R. Meldola. — *Fredk. J. Lloyd.*
Bernard Dyer.

Davy, S. W. M.,

Sharrow View, Sharrow, Sheffield.

Chemist and Gas Examiner to the Sheffield Gas Company. Apprentice with the South Down Metal Chemical Co., Ltd., 1879–82. Chemist at the Manchester Corporation Gas Works, 1882–88. Head Chemist to the Sheffield United Gas Light Co. (appointed 1888).

Henry Bird. — C. Kilpatrick.
R. L. Taylor. — Francis Jones.
Thornton Charles Lamb. — *Perceval Babington.*
Gilbert J. Fowler. — *Arthur W. Crossley.*

Green, Arthur Henry,

176, Lloyd Street, Greenheys, Manchester.

Analytical Chemist. I studied Chemistry under Mr. Francis Jones, Physics under Mr. John Angell, F.I.C., and Mathematics under Messrs. Holme, Buchheim, and Start at the Manchester Grammar School during 2 years (1884 to 1886). Then studied Chemistry during 5 years with Messrs. Crace-Calvert and Thomson at the Royal Institution Laboratory at Manchester, 3 years as pupil and 2 as assistant (1886 to 1891). I attended evening classes at Owens College under Dr. Bailey and Dr. Harden (1885 to 1888). I am now engaged in chemical investigation and analytical work at my own Laboratory.

William Thomson.
Arthur Harden.
John Angell.
George H. Hurst.
M. W. Jones.
G. H. Bailey.
Francis Jones.
Otto Hehner.
Charles E. Cassal.

Howitt, James John,

Dimley, Toft Road, Knutsford, Cheshire.

General Manager and Engineer of Chemical Works. I am a Chemical Engineer, also a Chemical Student; and Works General Manager (Chemical), and for many years been connected with Manufacturing Chemistry, and still engaged so.

Francis Henry Tate.
J. Carter Bell.
Watson Smith.
John Knowles.
Fredc. H. Bowman.
Vivian B. Lewes.

Leather, John Walter,

15, Bradgate Road, Catford, S.E.

Agricultural Chemist. Doctor of Philosophy. Dissertation:—"Die Pipizkörnsäure." Fellow of the Institute of Chemistry of Great Britain and Ireland. 5 years Senior Assistant to Dr. Voelcker in the Laboratory of the Royal Agricultural Society of England.

J. Augustus Voelcker.
J. H. Gilbert.
Bernard Dyer.
Charles E. Groves.
E. W. Voelcker.
P. Vieth.
Edward Kinch.
Henry E. Armstrong.

Lloyd, William Howard,

5, Belmont Villas, New Walk, Leicester.

Wholesale Manufacturing Chemist. Educated at the Wyggeston Hospital School or Leicester Grammar School. For two years head Assistant in the manufacturing Laboratory of Messrs. Richardson & Co., of this town, and since then 4 years' experience in manufacturing, pharmaceutical, and analytical work. Holder of the Assistant's Certificate of Apothecaries' Society and Associate of Pharmaceutical Society, and now of the firm of J. Howard, Lloyd, & Co., Manufacturing Chemists, Leicester.

William Harkness.
John Hodgkin.
J. Bell.
C. Proctor.
Samuel Francis Burford.
H. J. Helm.
J. Woodward.

McElroy, K. P.,

1412, Sixteenth Street, Washington, D.C., U.S.A.

Chemist. Second Assistant Chemist, United States Department of Agriculture; Vice-President (1893), Washington Chemical Society.

Edgar Richards. Clifford Richardson.
Edw. Gudeman. Charles E. Munroe.
C. F. Chandler. *Elwyn Waller.*
H. T. Vulté.

McKerrow, Charles Alexander,

41, Eccles Old Road, Pendleton, near Manchester.

Colorist and Chemist at the Clayton Aniline Co.'s works, Clayton, near Manchester. Author of "The Bleaching, Dyeing, and Finishing of Linen and Linen Goods," in course of publication in *The Textile Manufacturer*. Formerly day Student at Owens College, Manchester, and at the laboratories of Carter Bell, Esq.

Harold B. Dixon. Julius B. Cohen.
Francis Jones. Arthur Harden.
J. Carter Bell. *Arthur Smithells.*
William Thomson. *H. E. Roscoe.*

Mills, Charles,

Hazeldean, Fulham Palace Gardens, S.W.

Student in Chemistry, Central Institution, Exhibition Road, S.W. Associate of the City and Guilds Institute. Joint Author with Professor Armstrong of "The Action of Bromine on Azobenzene," *cf.* this Society's Proceedings, December 1, 1892.

Henry E. Armstrong. W. Palmer Wynne.
F. Stanley Kipping. W. J. Pope.
Arthur R. Ling.

Martin, Alexander Mitchell,

Douglas Villa, Dunbeth Road, Coatbridge.

Analytical Chemist and Metallurgist. Gartsherrie Iron Works (Messrs. William Baird and Co.). I have been for the past 6 years in charge of Laboratory of above iron smelting work, where also the bye-products are recovered from the furnace gases, with 4 years' previous training in Chemistry and allied Sciences in theory and practice.

R. R. Tatlock. Horatio Ballantyne.
Edmund J. Mills. A. Humboldt Sexton.
James G. Hardy.

Napier, John Watson,

Minto House, Edinburgh.

Analytical Chemist. Assistant for 4 years in the Laboratory of Mr. J. Falconer King, City Analyst, Edinburgh. Attended Lectures on Chemistry under Professor W. H. Perkin, jun., for three sessions.

J. Falconer King. John Hunter. W. H. Perkin, jun.
Hugh Marshall. G. H. Gemmell.

Orndorff, William Ridgely,

Ithaca, N.Y., U.S.A.

Assistant Professor of Chemistry in Cornell University, A.B. and Ph.D. Johns Hopkins University, Baltimore, M.D. Have published the following papers:—"Decomposition of Diazo-compounds with Alcohol" (*Amer. Chem. J.*, **9**, 387; **12**, 153; **14**, 45); "Decomposition of Acetone with Bleaching Powder" (*Amer. Chem. J.*, **10**, 363); "Metapropionic and Parapropionic Aldehydes" (*Amer. Chem. J.*, **12**, 352), and several other papers and reports in the same Journal.

John A. Miller, Ph.D. W. H. Chandler.
C. F. Chandler. *Elwyn Waller.*
H. T. Vulté.

Orr, Alexander,

109, Pitt Street, Sydney, Australia.

Analytical Chemist. Assayer and Metallurgist. Inventor of the Orr White Lead Process—works now erecting in Belgium. In England, company is being formed by "Alliance Pure White Lead Syndicate."

Robert R. Tatlock. John Clark. Edw. C. Stanford.
John Hargreaves. *John W. Towers.*

Pring, Charles Herbert,

The Ferns, Longfield Road, Bristol.

Student. Student in Chemical Laboratory Merchant Venturers' School, Bristol, for two years, and still there engaged in Analytical work. Pharmaceutical "Minor" qualification. Two years Principal of Laboratory at Messrs. Clements & Co., Manufacturing Chemists, Bristol. At present engaged in Research, Repurification of Crude Animal Oils, &c.

Ernest H. Cook. James Leicester. Thos. Coomber.
Henry J. Palmer. T. W. G. Blyth. J. Wertheimer.

Ritchie, George,

8, Buchanan Gardens, Mount Vernon, N.B.

Analytical Chemist. Chief Chemist at Parkhead Forge, Glasgow. Studied at City Analyst's Laboratory under Robt. Tatlock, Esq. For past ten years have been engaged in the study and practice of Analytical Chemistry. Author of "Gaseous Fuel and its Production."

Robert R. Tatlock.
A. Humboldt Sexton.
T. F. Barbour.
John Clark.
Horatio Ballantyne.
J. E. Stead.
Jas. G. Hardy.

Sessions, Wilfred,

Russell House, Gloucester (at present Leighton Park, Reading).

Schoolmaster. Science Master at Leighton Park School. Have taught Science for one year at Sidcot School. London Bachelor of Science. Three years' Student in Owens College Laboratories.

Harold B. Dixon.
Arthur Harden.
P. J. Hartog.
G. H. Bailey.
Gilbert J. Fowler.
W. H. Perkin, jun.

Sorrell, Henry Tho.,

Holly Lodge, Hill, Southampton West.

Chemical Lecturer. Milldown Laboratory, Blandford. Late Brewer at the Shirley Brewery, Croydon, and at the Hatcham Brewery, New Cross. Late Science Master at High School, Heaton Chapel, Manchester. Honours Inorganic Chemistry and 1st Class Organic Science and Art Department.

Chapman Jones.
John M. H. Munro.
Henry P. Harris.
W. Palmer Wynne.
Wm. Tate.

Thompson, Frank Ernest,

97, Murdoch Road, Handsworth, Birmingham.

Teacher of Chemistry. (1) An Associate of the Royal College of Science, London, in the division of Chemistry. (2) Hold three Honours Chemistry (Science and Art Examinations): 1st class Honours Practical Inorganic Chemistry; 1st class Honours Practical Organic Chemistry (1st bracket); 2nd class Honours Theoretical Inorganic Chemistry. (3) Engaged as Teacher of Chemistry at the Waverley Road Technical School, Small Heath, Birmingham, and at the Dudley Institute.

Chapman Jones.
William Tate.
Alfred E. Tutton.
F. R. Japp.
E. J. Cox.

Vautin, Claude Theodore James,

10, Hanover Square, London.

Metallurgist. Have been engaged in Metallurgical Chemistry during the past 18 years. Have devised successful process for refining metallic copper (at work, New South Wales). Co-inventor of Newbery-Vautin gold-extraction process. Devised process for extracting gold from tin (at work, Chiltern, Victoria). Introduced Matte smelting in Victoria at Bethanga. Devised plant from "Bessemering" copper and iron sulphides (Cobar, New South Wales), &c. At present investigating Aluminium Salts and the production of the metal, also in Electrolytical separations.

William Ramsay.	D. A. Louis.
Edward Bevan.	Chas. Fred. Cross.
William Crookes.	

Warmington, Edward Augustus,

266, Castle Street, Dudley.

Chemist. I have studied Chemistry for the last seven years, first at Mason College, Birmingham, under Professor Tilden, and then in Leipzig. In 1892 I obtained the degree of Doctor of Philosophy of Leipzig. I have contributed to Chemical Science a paper "Ueber Phenyluracil u. analoge Verbindungen," published in the *Journal für Praktische Chemie*, **47**, 201.

William A. Tilden.	W. W. J. Nicol.
Thomas Turner.	Credacre G. Moor.
William Ramsay.	

Whittaker, Thomas,

76, Arden Terrace, Accrington.

Chemical and Mechanical Engineer. Lecturer on Chemistry, Accrington Technical School. Past student Normal School of Science. Analyst to the Doury Iron Works, Accrington.

Percy F. Frankland.	John Wrightson.
Conrad Gerland.	Chapman Jones.
M. W. Jones.	

Wholly, Sydney,

38, Havelock Street, Canterbury.

Science Master. Associate (in Chemistry) of the Royal College of Science, London. Science Master, Simon Langton Schools, Canterbury.

W. Palmer Wynne.	Chapman Jones.
Alfred E. Tutton.	J. W. Rodger.
William Tate.	Lionel M. Jones.

The following Certificate is recommended by the Council under Bye-law I (par. 3) :—

Hancock, Ernest Albert,

Basseterre, St. Kitts, Leeward Islands.

Analyst. Government Analytical Chemist for the Presidency of St. Christopher-Nevis.

Francis Watts. John R. Bovell. *Henry E. Armstrong.*

HARRISON AND SONS, PRINTERS IN ORDINARY TO HER MAJESTY, ST. MARTIN'S LANE.

Issued 13/6/1893.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

No. 126. Session 1893–94.

June 1st, 1893. Dr. Armstrong, President, in the Chair.

Messrs. T. L. Baker, J. Addyman Gardner, James Mason, Robt. G. Grimwood and Reginald B. Brown were formally admitted Fellows of the Society.

The certificate of Frank Browne, Government Civil Hospital, Hong Kong, was read for the first time.

Of the following papers those marked * were read:—

*25. "Azo-compounds of the ortho-series." By R. Meldola, E. M. Hawkins and F. B. Burls.

The constitution of the orthazo-compounds is still an unsolved problem owing to the contradictory results obtained by different investigators using different methods. The evidence in some cases points to the hydrazone formula and in others to the azo-formula, represented in the case of the azo-β-naphthols respectively by $X{\cdot}NH{\cdot}N{:}C_{10}H_6{:}O$ and $X{\cdot}N_2{\cdot}C_{10}H_6{\cdot}OH$. The compounds may really be isodynamic, but their acetyl and benzoyl, &c., derivatives, which were first investigated by one of the authors and G. T. Morgan (*C.S. Trans.*, 1889, 114), can hardly be thus regarded. The best evidence in favour of the hydrazone formula was furnished by Goldschmidt and Brubacher (*Ber.*, 1891, 2300), who obtained acetanilide and benzanilide by reducing the acetyl and benzoyl derivatives by means of zinc dust and acetic acid in alcoholic solution; these products are not obtained when stannous chloride is used as the reducing agent, a fact which was made known in 1889 in the paper referred to and which has been confirmed in the present investigation.

In repeating Goldschmidt and Brubacher's work with the acetyl derivatives of ortho- and para-tolueneazo-β-naphthol, the authors have found that acetamido-β-naphthol is also one of the products of reduction, and in the case of a number of other acetyl derivatives this compound is found to be a normal product of reduction. Thus, in the case of an acetyl derivative of the form $X{\cdot}N_2{\cdot}C_{10}H_6{\cdot}OC_2H_3O$ or $X{\cdot}N(C_2H_3O){\cdot}N{:}C_{10}H_6{:}O$, four products are always obtained when zinc dust and acetic acid is the reducing agent, viz.:—$X{\cdot}NH{\cdot}C_2H_3O$, $C_{10}H_6(NH{\cdot}C_2H_3O){\cdot}OH\beta$, $X{\cdot}NH_2$ and $C_{10}H_6{\cdot}NH_2{\cdot}OH\beta$. The quantity of acetamido-β-naphthol is very small in the case of the acetyl derivative of benzeneazo-β-naphthol, a fact which accounts for this product having been overlooked by Goldschmidt and Brubacher. As the number of methyl groups in X is increased, the quantity of acetamido-β-naphthol increases, the acetyl derivative of pseudocumeneazo-β-naphthol giving about 9·2 per cent. of this product when reduced by zinc dust and acetic acid in the manner described.

The following azo-compounds and their acetyl derivatives have been isolated and characterised in the course of the investigation:—

p-Tolueneazo-β-naphthol (acetyl derivative)	Red prisms, m. p. 99°.
p-Chlorobenzeneazo-β-naphthol (acetyl derivative)	Flat needles or leaflets, red, m. p. 133°.
Pseudocumeneazo-β-naphthol ...	Bronzy prisms or bright scarlet needles, m. p. 163—164°.

Other acetyl derivatives have been prepared, but used immediately for reduction for reasons explained in the paper. The acetyl derivative of benzeneazo-β-naphthol has been reduced under various conditions, and is always found to give a small quantity of acetamido-β-naphthol except when stannous chloride is used, when the chief product appears to be either a naphthylphenyl or a naphthylphenylamine derivative. The latter will be made the subject of a special investigation. Even when zinc dust and chlorhydric acid were used as reducing agents, acetamido-β-naphthol was obtained, but the quantity of acetanilide is in this case insignificant, the chief products being amido-β-naphthol and aniline.

The authors conclude that the formation of acetamido-β-naphthol on reduction is destructive of Goldschmidt and Brubacher's evidence in favour of the hydrazone formula for the ortho-azo-compounds. The simultaneous formation of acetanilide, acettoluide, &c., and acetamido-β-naphthol cannot be explained by either azo- or hydrazone formula alone, but if it be assumed that an intermediate product of the nature of an anhydro-compound is formed, the production of these compounds is accounted for. It is shown in the paper that the same anhydro-compound would be produced whether the acetyl group were attached to nitrogen or oxygen in the original compound, so that the question of the constitution of the ortho-azo-compounds still remains an open one. Further experiments on the reduction of the acetyl and benzoyl derivatives of other ortho-azo-compounds are in progress.

*26. "The production of a fluorescein from camphoric anhydride." By J. Norman Collie, Ph.D., F.R.S.E.

Last year the author proposed a formula for camphoric acid of the succinic type (*Ber.*, 25, 1116). Up to that date no fluorescein had been prepared from camphoric anhydride, and it had even been stated that this anhydride did not form such a compound (J. E. Marsh, *C.S. Trans.*, 1891, 651); it therefore seemed necessary to institute further experiments to obtain an explanation of this apparently anomalous behaviour of camphoric anhydride. The author finds that under suitable conditions camphoric anhydride is without difficulty converted into a fluorescein, the best results being obtained by heating one molecular proportion of the anhydride with two molecular proportions of resorcinol to about 180° C. with a relatively small amount of zinc chloride.

The resulting fluorescein, ($C_{22}H_{22}O_5$), is a reddish-brown powder, which, when dry, has a greenish lustre. It dissolves in alkalis, affording a pink coloured solution, and exhibits in dilute aqueous solutions a beautiful green fluorescence.

When sulphuric acid is employed in its preparation, the yield of fluorescein is small, the chief product being a brown compound which dyes cotton mordanted with alumina a pink colour.

The author finds that isopropylglutaric anhydride also furnishes a fluorescein, so that the production of a fluorescein from camphoric acid does not afford evidence which can be made use of in deciding whether the acid is a compound of the succinic or of the glutaric type.

*27. "Researches on the terpenes. III. The action of phosphorus pentachloride on camphene." By J. E. Marsh and J. A. Gardner.

The authors describe the results of the further study of the action of phosphorus pentachloride on camphene. When these substances are allowed to interact without heat being applied, a mixture of camphene hydrochloride and a chlorophosphonic derivative of the formula $C_{10}H_{15}PCl_4$ is obtained. On treatment with water, the latter compound is converted into a mixture of acids which, together with the camphene hydrochloride, forms a syrupy mass, from which the acids are separated by fractionally extracting with a solution of sodium carbonate. After further purification by means of suitable solvents, two well characterised isomeric camphenephosphonic acids of the formula $C_{10}H_{15}PO_3H_2$ were obtained.

α-Camphenephosphonic acid, crystallised from dilute alcohol, has a composition represented by the formula $2C_{10}H_{15}PO_3H_2 + H_2O$. It is characterised by its insolubility in ether and ready solubility in chloroform; when heated at 100° it loses the elements of two molecules of water. The anhydrous acid melts at 184°. The acid is monobasic. The sodium salt crystallises from water or alcohol; the barium salt forms an almost insoluble crystalline precipitate.

β-Camphenephosphonic acid, crystallised from dilute alcohol, has the composition $C_{10}H_{15}PO_3H_2$. It does not lose weight when heated during several hours at 100°, but on prolonged heating it turns brown, melts, and loses weight. It is readily soluble in ether, but insoluble in chloroform; it melts at 170°. The acid is monobasic. The sodium and ammonium salts have been prepared.

The α- and β-acids further differ in rotatory power. When prepared from camphene having a rotatory power of $-60°$, the specific rotatory power of the α-acid was $[\alpha]_D = -119°$, and that of the β-acid $-71°$.

When the mixture of phosphorus pentachloride and camphene is heated, a crystalline compound of the formula $C_{10}H_{14}PCl_3$ is obtained, which has been previously described (*C.S. Trans.*, 1891, 652). When subjected to the action of a solution of sodium carbonate, this compound yields a sodium salt of the formula $C_{10}H_{14}ClPO_2NaH + 5H_2O$. The corresponding barium salt is soluble in water, and crystallises with three molecular proportions of water. The acid is an oil. On oxidation by potassium permanganate in alkaline solution, it is converted into the corresponding *chlorocamphenephosphonic acid*, $C_{10}H_{14}PO_3H_2$. This may be crystallised from benzene; it melts at 178°, undergoing decomposition. When a mixture of camphene with a larger excess of phosphorus pentachloride is heated, and the product is hydrolysed, the same chlorocamphenephosphonic acid is obtained, together with an isomeric acid. The sodium salts of all these phosphonic acids are acted on by bromine, the phosphonic group appearing in solution as sodium phosphate, brominated derivatives of camphene being produced which are under investigation. On oxidation by nitric acid, chlorocamphenephosphonic acid yields camphoic acid. On fusing chlorocamphenephosphonic acid with potash, a very small quantity of a crystalline volatile substance was obtained.

*28. "The composition of a specimen of jute fibre produced in England." By Andrew Pears, jun.

The author succeeded in securing a normal growth of the jute plant (*Corchorus capsularis*) in a "hot house" of average temperature 65° F. The stems, 5 feet in length, and branched, were cut down after maturation of the seed, which has since been germinated for growth during the current year. The stem-fibre was separated after retting in tepid water, and was exhaustively investigated. It showed the characteristic behaviour of lignocelluloses, but with important variations in degree; the most marked difference observed was in ultimate composition, the carbon percentage being only 43 as against 46—47 in the normal fibre. From the results given in full in the paper, it is shown that the factors of lignification induce variations in chemical composition, within wide limits, at the same time that the general constitutional type is preserved. Lignification may, in fact, be regarded as a gradual passage from "saturated" to "unsaturated" compounds, and as the result of the splitting off of water and carbon condensation, the specimen in question representing the earlier phases of such transition or evolution.

29. "Note on the combination of dry gases." By W. Ramsay, F.R.S.

Mr. H. Brereton Baker has stated in his recent note that when dry ammonia is mixed with dry hydrogen chloride, these gases do not combine to form ammonium chloride; I would, therefore, call attention to a statement to the same effect by Dr. Sydney Young and myself in a paper on "Evaporation and dissociation," published in the *Phil. Trans.*, 1886, Part I, p. 89. After describing the behaviour of ammonium chloride at 280° in a modified Hofmann's vapour-density tube, we state:—"When the tube cooled, a permanent gas remained, which exerted a pressure of 18·3 mm. As a very long time was allowed, so as to make certain of no further rise (of pressure) when the ammonium chloride was heated, the presence of this gas cannot be accounted for by a gradual decomposition of the ammonia, for we have shown (*J. Chem. Soc.*, 1884, 88) that ammonia begins to decompose only at 500°, even when hydrochloric acid is absent. It might, however, to some extent be due to the action of hydrochloric acid on mercury. On inclining the tube, this gas formed a bubble of considerable size at the top. Water was introduced, and almost complete absorption occurred. It appears certain then that gaseous hydrogen chloride and ammonia, when perfectly dry, combine very slowly."

These experiments were made in order to measure the vapour pressure of ammonium chloride; hence there was always a large excess of solid chloride present. It appears, therefore, that even in presence of the associated solid compound, the gaseous constituents may remain in presence of each other without combining.

I was not so successful as Mr. Baker has been in preventing the combination of nitric oxide and oxygen. Even after a bulb of nitric oxide containing several grams of phosphoric anhydride—itself contained in a bulb of oxygen in which there was a considerable quantity of the anhydride—had been left during three months, on breaking the thin-walled inner bulb, a red colour was at once seen. I cannot but conclude that some substance other than water vapour may also have the power of effecting such combination; unless, indeed, it be contended that such a lengthened exposure to phosphoric anhydride does not completely dry the gases.

30. "Ortho-, para- and peri-disulphonic derivatives of naphthalene." By Henry E. Armstrong and W. P. Wynne.

In a previous communication, dealing with the results of the examination of a large number of disulphonic acids (these Proceedings, 1890, 133) attention was drawn to the " 'invincible objection' of two sulphonic radicles to *remain* in either contiguous or para- or peri-positions " relatively to one another when disulphonic acids are formed by the action of sulphuric acid either on naphthalene or on the chloro-, amido- or hydroxy-naphthalenes. Further investigation has failed to supply a single exception to this rule, and it is noteworthy that of the known disulphonic acids only two—the No. II α-naphthylaminedisulphonic acid of Dahl & Co.'s German Patent No. 41957 (*loc. cit.*, p. 125), and the minor product of the sulphonation of potassium 2 : 3′-chloronaphthalenesulphonate (*loc. cit.*, p. 132)—contain the two sulphonic radicles relatively in the positions 1 : 2′, the favoured positions being 1 : 4′, 2 : 4′, 2 : 2′ and 2 : 3′, the position 1 : 3 being taken up only in the case of sulphonation products of certain β-chloro- and β-amido-naphthalenesulphonic acids. Moreover, while the number of naphthalenedisulphonic acids obtainable, either by the sulphonation of naphthalene or by eliminating the NH_2 radicle from naphthylaminedisulphonic acids amounts to six, it is very significant that only two naphthylaminetrisulphonic acids—the 1 : 3 : 2′- and 1 : 3 : 3′-derivatives—can be obtained by sulphonating naphthalene, and that the only trisulphonic acids obtained by sulphonating the naphthols and naphthylamines contain their sulphonic radicles relatively in one or other of these positions.

While preparing the final account of our seven years' investigations, we endeavoured in various ways to prepare the missing acids containing the sulphonic radicles in the positions which are avoided in all products of direct sulphonation, so that their behaviour towards sulphonating agents might be studied in order that the explanation of this remarkable law of substitution might be given. While engaged in these experiments, we learnt with great satisfaction from Dr. C. Duisberg that a process had been devised in the laboratory of the Farberfabriken vormals F. Bayer & Co., of Elberfeld which had enabled them to prepare all the acids we were in search of, and with that courtesy which is characteristic of German chemical manufacturers, Dr. Duisberg at once communicated their method to us, so that we might proceed to study the various acids from the scientific side.

The process consists in displacing the amido-group in a naphthylamine derivative by SH and oxidising the resulting thio-derivative by means of alkaline permanganate; the thihydride is prepared by Leuckart's method (*J. pr. Chem.* [2], **41**, 218) by submitting the diazo-compound prepared from the amine to treatment with potassium xanthate and hydrolysing the resulting xanthate. The thihydride thus formed being unstable in presence of oxygen, the corresponding disulphide is usually obtained. The process is described in the German Patent Anmeldung F. 6099, Cl. 22, of the Farbenfabriken vorm. Friedr. Bayer & Co., Elberfeld, in which an account is given of three new disulphonic, seven new trisulphonic and two tetrasulphonic acids of naphthalene. With no more information before us than is afforded by the specification, we have been able without the slightest difficulty to prepare the various acids, and we have nothing to add to the admirable description given in the specification—a striking illustration of the character of the German chemical patent literature of the day.

In the present note only three new disulphonic and one new trisulphonic acid are referred to; the remaining acids will be described in a later communication. On treatment with phosphorus pentachloride, the 1 : 1′- and 1 : 2-acids yield products which apparently are the corresponding anhydrides. This behaviour is of interest as an extension of the observations made in V. Meyer's laboratory on the formation of anhydrides of disulphonic acids of thiophen It is remarkable that the R-acid, in which there are two contiguous β-sulphonic groups, has not been found to yield an anhydride.

In the first instance, we availed ourselves of the method to prepare from the (Badische) 1 : 2′-β-naphthylaminesulphonic acid the 1 : 2′-naphthalenedisulphonic acid previously discovered by us (these Proceedings, 1890, 125). The product is identical with that obtained from Dahl's No. II α-naphthylaminedisulphonic acid, and thus an independent proof is afforded of the somewhat remarkable constitution which we have assigned to this acid.

1 : 1′-*Naphthalenedisulphonic acid* was prepared from the Schöllkopf 1 : 1′-α-naphthylaminesulphonic acid kindly placed at our disposal by the Actiengesellschaft für Anilinfabrikation, Berlin. The corresponding *potassium naphthalenesulphidesulphonate*, $(C_{10}H_6S\cdot SO_2K)_2 + H_2O$, crystallises in very small, pale yellow scales, sparingly soluble in cold water. *Potassium* 1 : 1′-*naphthalenedisulphonate*, $C_{10}H_6(SO_3K)_2 + H_2O$, crystallises in well-defined, four-sided scales, sparingly soluble in hot water; what appears to be the corresponding *anhydride* crystallises in small, rhomboidal, probably monosymmetric plates, melting at 227°, which are sparingly soluble in hot benzene, more soluble in hot xylene and acetic acid.

1 : 2-*Naphthalenedisulphonic acid* was obtained from the Landshoff and Meyer 1 : 2-α-naphthylaminesulphonic acid. The corresponding *potassium naphthalenesulphidesulphonate* $(C_{10}H_6S\cdot SO_3K)_2 + 4H_2O$, crystallises in pale yellow granules consisting of microscopic prisms sparingly soluble in cold water. *Potassium* 1 : 2-*naphthalenedisulphonate*, $C_{10}H_6(SO_3K)_2 + \frac{2}{3}H_2O$, crystallises from water in very soluble, prismatic tables; what appears to be the corresponding *anhydride* crystallises from benzene, in which it is tolerably soluble, in elongated, striated prisms melting at 198°.

1 : 4-*Naphthalenedisulphonic acid* was prepared from naphthionic acid. The corresponding *potassium naphthalenesulphidesulphonate* $(C_{10}H_6S\cdot SO_3K)_2 + 2H_2O$, crystallises from water in easily soluble, pale yellow, microcrystalline granules. *Potassium* 1 : 4-*naphthalenedisulphonate*, $C_{10}H_6(SO_3K)_2 + 1\frac{1}{3}H_2O$, crystallises from water in small, readily soluble needles; the corresponding *chloride*, $C_{10}H_6(SO_2Cl)_2$, crystallises from benzene, in which it is readily soluble, in four-sided, monosymmetric plates showing an optic axis just beyond the edge of the microscope field: this melts at 160°.

2 : 2′ : 3′-*Naphthalenetrisulphonic acid* was obtained from 2 : 2′ : 3-β-naphthylaminedisulphonic acid (amido-R-acid). The corresponding *potassium naphthalenesulphidedisulphonate* $[C_{10}H_5S(SO_3K)_2]_2 + 5H_2O$, crystallises from water in finely striated, prismatic forms having a beautiful, velvet-like appearance. *Potassium* 2 : 2′ : 3′-*naphthalenetrisulphonate*, $C_{10}H_5(SO_3K)_3 + 3H_2O$, crystallises from water in small, microcrystalline, spherical aggregates; the corresponding *chloride*, $C_{10}H_5(SO_2Cl)_3$, crystallises from benzene, in which it is tolerably soluble, in long, flat, probably monosymmetric plates showing longitudinal striations, melting at 200°.

The method of substituting the SO_3H radicle for NH_2 has been extended to the chloro-β-naphthylaminesulphonic acids, and in particular to the 1 : 2 : 2′- or "No. 3" acid, with the object of comparing the product with the α-chloronaphthalene-2 : 2′-disulphonic acid obtained from Alén's α-nitronaphthalene-2 : 2′-disulphonic chloride, to which Cleve attributes a like constitution (*Ber.*, **25**, 2490). We take this opportunity of stating that further investigation has shown that, contrary to our previously expressed view (*cf.* these Proceedings, 1890, 135), the No. 2 and No. 3 acids have an independent origin.

By the discovery of the disulphonic acids here described, we are now placed in possession of nine of the ten possible acids. We have previously characterised the ten possible dichloronaphthalenes and the two homonucleal trichloronaphthalenes (these Proceedings, 1890, 76, 77); we have now all but completed the study of the remaining twelve trichloronaphthalenes, having converted them into sulphonic acids, &c., in order that it may be possible to characterise them beyond question. So soon as the few remaining comparisons are completed, a detailed account of the investigation will be submitted.

Experiments are being carried out in the Central Institution laboratory by one of us with the object of determining, by means of the xanthate method, whether in the case of other hydrocarbons orthodisulphonic acids can be obtained which can exist in presence of sulphonating agents—the statements on record being far from satisfactory, and in some cases contradictory.

31. "Supplementary notes on madder colouring matters." By E. Schunck, Ph.D., F.R.S., and L. Marchlewski.

Many years ago (*Phil. Trans.*, 1853, 72) one of the authors described under the name of rubiadin a yellow colouring matter obtained from madder. It is now shown that madder contains a glucoside of this substance, the preparation and properties of which are described. The glucoside crystallises in yellow needles melting at about 270°. On acetylation by Liebermann's method, it yields a pentacetyl derivative. On treatment with baryta water, it yields a dark red lake, one hydrogen atom being displaced by barium. On hydrolysis, it is converted into rubiadin and ordinary dextrose, $C_{21}H_{20}O_9 + H_2O = C_{15}H_{10}O_4 + C_6H_{12}O_6$.

Rubiadin crystallises in lustrous, yellow needles melting at 290°. It very closely resembles purpuroxanthin, and is probably the corresponding derivative of methylanthracene.

32. "The constitution of rubiadin glucoside and of rubiadin." By L. Marchlewski.

It is pointed out that of the five hydroxyl groups in rubiadin, one is phenolic, inasmuch as the glucoside yields dark red coloured monometallic derivatives; further, it is contended that probably glucose always exists in glucosides in the form of an anhydride of a heptahydric alcohol; a formula is assigned to the glucoside based on these arguments.

Assuming that rubiadin is derived from the same (β) methylanthracene as emodin, &c., it is pointed out that there are still three possible formulæ if rubiadin be regarded as a meta-dihydroxyanthraquinone—one homo- and two hetero-nucleal.

By heating a mixture of symmetrical metadihydroxybenzoic acid, paramethylbenzoic acid and sulphuric acid at 110°, the author has obtained a substance of the same composition and closely resembling rubiadin, but melting at 267°.

At the next meeting, on June 15th, there will be a ballot for the election of Fellows, and the following papers will be read:—

"Contributions to our knowledge of the aconite alkaloids. VI. Conversion of aconitine into isaconitine." By Professor Dunstan and F. H. Carr.

"VII. Modifications of aconitine aurichloride." By Professor Dunstan and H. A. D. Jowett.

"Properties of strong solutions." By S. U. Pickering, F.R.S.

"Notes on the stereoisomerism of nitrogen compounds." By S. U. Pickering, F.R.S.

"New methods of analysis." By Dr. J. Clark.

"Studies on citrazinic acid." By W. J. Sell and T. H. Easterfield.

And other papers.

HARRISON AND SONS, PRINTERS IN ORDINARY TO HER MAJESTY, ST. MARTIN'S LANE.

Issued 19/8/1893.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

No. 127. Session 1893-94.

June 15th, 1893. Dr. Armstrong, President, in the Chair.

Mr. T. H. Easterfield was formally admitted a Fellow of the Society.

Certificates were read for the first time in favour of Messrs. Henry Ormsby Hale, B.A., Oundle School, Northamptonshire; Thomas Beilby Rawlins, 2, Leven Street, Pollockshields, Glasgow; Herbert Santer, Albion Brewery, Caledonian Road, N.; William Gilchrist White, Lamb Roe, Whalley, Lancashire; Edward Humphreys Winder, 37, Vincent Square, S.W.

The following were duly elected Fellows of the Society:—John Bateman, Henry Bailey, Douglas T. C. Berridge, Robert S. Cahill, John Henry Coste, S. W. M. Davy, Arthur Henry Green, Ernest Albert Hancock, James John Howitt, John Walter Leather, Alexander Mitchell Martin, Charles Mills, Charles Alexander McKerrow, K. P. McElroy, John Watson Napier, William Ridgely Orndorff, Alexander Orr, George Ritchie, Wilfred Sessions, Henry Thomas Sorrell, Frank Ernest Thompson, Claude Theodore Vautin, Edward Augustus Warmington, Thomas Whittaker, Sydney Whally.

Of the following papers those marked * were read:—

***33. "Contributions to our knowledge of the aconite alkaloids. Part VI. Conversion of aconitine into isaconitine." By Wyndham R. Dunstan, M.A., F.R.S., and Francis H. Carr.**

In a previous communication it has been shown that the roots of *Aconitum Napellus* contain, besides the highly poisonous aconitine, an almost non-poisonous isomeride—isaconitine. These alkaloids are evidently intimately related, as both furnish aconine and benzoic acid on hydrolysis. The authors now show that when an aqueous solution of aconitine hydrobromide (m. p. 163°) is heated, change very gradually takes place, the isomeric *isaconitine hydrobromide* (m. p. 282°) being produced. The change is facilitated by the addition of a small quantity (1—2 per cent.) of hydrogen bromide, but is not assisted if sufficient is present to induce hydrolysis of a large proportion of aconitine. The isaconitine was identified not only by the high melting point of its salts, but also by the formation and analysis of the characteristic auchlorisaconitine. No similar change could be detected in the case of aconitine nitrate, either when neutral or acid solution was used, nor could the conversion be effected by heating aconitine with glacial acetic acid, although in this case anhydraconitine is produced if the heating be continued during 18 hours at 120°. Aconitine may be dissolved in concentrated sulphuric acid, and the solution gently heated without the conversion into isaconitine taking place; nor does aconitine sulphate undergo conversion into the isomeride when it is heated many hours in contact with very dilute sulphuric acid. No isaconitine seems to be produced during the hydrolysis of aconitine by cold soda solution. The authors are making further experiments in the hope of gaining information with regard to the mechanism of the conversion of aconitine hydrobromide into isaconitine hydrobromide.

*34. "Contributions to our knowledge of the aconite alkaloids. Part VII. Some modifications of aconitine aurichloride." By Wyndham R. Dunstan, M.A., F.R.S., and H. A. D. Jowett.

Certain irregularities having been observed in the melting point of aconitine aurichloride, $C_{33}H_{45}NO_{12},HAuCl_4$ (see Part I) prepared under different conditions from pure aconitine, the subject was fully investigated, the result being that three distinct isomeric modifications have been isolated differing in melting point and crystalline form.

When auric chloride is added to a solution of aconitine hydrochloride, a yellow, amorphous precipitate is thrown down from which directly or indirectly the three crystalline modifications can be obtained by employing different solvents. *Aconitine α-aurichloride* is most readily produced in rosettes of needles by crystallisation from a mixture of acetone and water, or less readily and certainly in rectangular plates from dilute alcohol. The crystals melt at 135·5°. When recrystallised from strong alcohol, this compound changes into the β-modification.

Aconitine β-aurichloride is obtained by crystallising from strong alcohol. It forms rosettes of needle-shaped crystals which melt at

152°. When this substance is recrystallised from a mixture of chloroform and ether it changes into the γ-modification, and when recrystallised from a mixture of acetone and water it appears as the α-modification.

Aconitine γ-aurichloride cannot apparently be formed directly from the amorphous precipitate or from the α-aurichloride. It is, however, easily prepared by recrystallising the β-aurichloride from a mixture of chloroform and ether, when it separates in prisms melting at 176°. When crystallised from strong alcohol, this substance is converted into needles of the β-aurichloride; and on crystallising it from a mixture of acetone and water, the α-modification is obtained. When the β- and γ-modifications are melted they pass into the α-aurichloride. From each of the modifications one and the same crystalline aconitine (m. p. 188—189°) may be recovered. They behave, then, as true "physical" isomerides, no chemical difference being detectable between them.

*35. "Note on the stereoisomerism of nitrogen compounds." By S. U. Pickering.

Hantzsch and Werner's suggestion that the isomerism of some triad nitrogen compounds may be explained by referring them to a tetrahedron and assuming that the nitrogen occupies one corner instead of the centre is tantamount to representing one side only of the nitrogen atom as capable of entering into combination. It leads to further difficulties when the nitrogen becomes pentad, as, in order to preserve the tetrahedral form, the nitrogen atom has to be placed in the centre of the tetrahedron together with one of the monad atoms. An alternative explanation which has been offered is based on the supposition that the isomerides are produced according as one of the bonds of the nitrogen atoms inclines towards one or other of the groups in its vicinity, an explanation for which the study of compounds of other elements affords no justification. In suggesting an arrangement of atoms in space, our ignorance of the matter renders the simplest possible arrangement the only justifiable one. This, in the case of an atom combining with three or five others, is that three of these should be arranged in one plane at equal distances around the central atom, the other two being placed in a plane at right angles, so that each of them is equidistant from the first three. This arrangement, though not symmetrical, is the most nearly symmetrical one possible. It affords, in the author's opinion, a perfect explanation of the stable character of ammonia derivatives, and of the fact that in ammonium derivatives two of the groups can be very easily split off. It explains the isomerism found in the hydroximes and hydrazones by one of the groups present being united by different bonds in the two cases (two of the five bonds being always free), just as in the isomerism of carbon compounds, and it agrees well with the facts as to isomerism and optical activity observed in the case of ammonium derivatives. Moreover, as the nitrogen atom can form a symmetrical compound with any two, as well as with three, of its bonds occupied, it also affords an explanation of the existence of nitric oxide and peroxide.

*36. "A study of the properties of some strong solutions." By S. U. Pickering.

The depressions of the freezing points of the three solvents water, acetic acid and benzene by a number of non-electrolytes (methyl, ethyl and propyl alcohols, diethylamine, pyridine, ethyl ether, carbon bisulphide, acetic anhydride) were examined, the determinations being extended to the strongest solutions possible. The results showed that the slight irregularities which are observable in the results afforded by weak solutions become one of the most marked features in the case of strong solutions, and any theory which attempts to explain the nature of solutions while ignoring the existence of these irregularities must necessarily be imperfect. The nature of the dissolved substance has an obvious effect on the character of the results, but it is impossible to ascribe this character to the nature of the dissolved substance only, as the peculiarities exhibited by a particular substance in one solvent are often absent when another solvent is used; these peculiarities would appear to be explicable only on the assumption that every solution contains substances peculiar to itself—*i.e.*, compounds of the solvent and substance—and does not consist merely of the juxtaposed free solvent and free substance.

In the various series, 29 breaks were observed in the regions embracing fairly simple molecular proportions (1 : 4 to 4 : 1 mols.), and of these, 24 agree within experimental error with molecular proportions, the remaining 5 being breaks whose existence or position was doubtful. Additional evidence is thus afforded as to the existence and significance of these breaks, and their occurrence is shown not to be confined to cases in which the solvent is water.

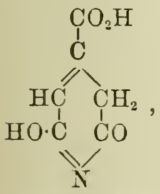
*37. "Studies on citrazinic acid." By W. J. Sell and T. H. Easterfield.

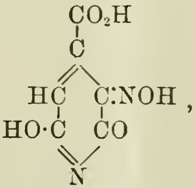
A new method of preparing citrazinamide is described, which consists in fusing a mixture of citric acid and urea. The alkali salts of the amide and the normal and acid alkali salts of the acid are described, and an account is given of trichlorcitrazinic acid and its behaviour with phenylhydrazine.

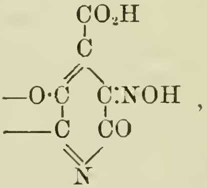
The authors find that the production of a blue colour when citrazinic acid is warmed with dilute solutions of potassium nitrite is due to the formation of a quinhydroketopyridine, a substance whose alkaline solution has an intense blue colour; this, however, is only the final stage of a series in which isonitrosocitrazinic acid is first formed. The isonitroso-compound is very unstable; it is oxidised by nitric or nitrous acid and converted into a stable, yellow acid of the formula $C_6H_2N_2O_5{\cdot}4H_2O$; hence, if an excess of nitrite be employed in applying the colour test for citrazinic acid, no blue colour results. The yellow acid is dibasic, and its solutions precipitate potassium or ammonium salts from solutions of the chlorides of those metals.

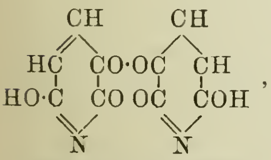
By the action of dilute sulphuric acid or of reducing agents, isonitrosocitrazinic acid is converted into $\alpha\beta'$-quinhydro- and α-ketopyridine, which crystallises in lustrous, bronze-green coloured prisms. The same substance may be produced by reducing the yellow acid. The quinhydrone is easily converted by oxidation into the corresponding quinone, which resembles ordinary quinone in many of its properties, and may be reconverted by sulphurous acid and other reducing agents to the quinhydrone. On reduction the quinhydrone gives a colourless solution which probably contains the quinol, as, on exposure to air, the liquid begins at once to deposit crystals of the quinhydrone; the quinol has not yet been isolated.

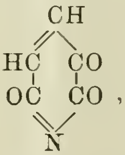
A bright red coloured phenylhydrazocitrazinic acid, corresponding to the above isonitroso-derivative, is obtained by the action of diazobenzene chloride on citrazinic acid; this substance forms characteristic salts. The following formulæ are provisionally suggested for the substances described:—

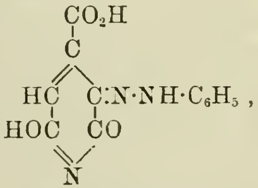

Citrazinic acid.

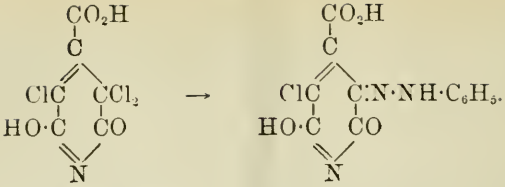

Isonitrosocitrazinic acid.


Yellow acid, ½ mol.


Quinhydroketopyridine.


Quinoketopyridine.


Phenylhydrazocitrazinic acid.



Trichlorcitrazinic acid. Chlorphenylhydrazocitrazinic acid (as salts).

DISCUSSION.

Dr. KIPPING said the published statements regarding citrazinic acid agree in assigning to it the property of fluorescence, which, according to Dr. Armstrong's views on the origin and nature of colour, it should not possess, assuming it to have the usually accepted constitution. At Dr. Armstrong's suggestion, Mr. O. F. Russell and himself undertook to settle, if possible, this question of fluorescence, and for this purpose they prepared citrazinic acid by two methods, of which that described by Behrmann and Hofmann was found to give the better results, the acid obtained by Ruhemann's process from ethylic acetylcitrate being difficult to purify.

A freshly prepared alkaline solution of the crude product is highly fluorescent, but when the acid is carefully purified by converting it into the ethylic salt and crystallising the latter from acetic acid, this is no longer the case. A small quantity of pure citrazinic acid dissolved in concentrated soda gives a colourless solution without visible fluorescence; on shaking for a few minutes in contact with air a slight but gradually increasing blue fluorescence is observed, caused doubtless by the presence of some oxidation or decomposition product of the acid. A solution containing pure ethylic citrazinate together with sodium carbonate becomes fluorescent on exposure to the air, but apparently more slowly than a solution of the acid.

Some further experiments were made with citrazinic acid with the object of elucidating its constitution. Ethylic citrazinate gave with acetic anhydride a colourless, crystalline diacetyl derivative, $C_{12}H_{13}NO_6$, the composition of which was determined by the ordinary methods and by direct estimation of the quantity of acetic acid produced on decomposition with sulphuric acid. Attempts to prepare a hydrazone and a hydroxime from citrazinic acid were unsuccessful. By suspending citrazinic acid in water and passing nitrous fumes into the ice-cold mixture, a substance of the composition $C_6H_6N_2O_6$, which is evidently identical with the authors' isonitrosocitrazinic acid, was obtained; this compound can be obtained in almost colourless crystals by recrystallisation from ethylic acetate and petroleum. The action of potash and methyl iodide on citrazinic acid seems to be quite abnormal, but the nature of the product, which was of an uninviting character, was not determined. Citrazinic acid combines with dry bromine, yielding a crystalline substance which is readily soluble in water and ethylic acetate; it is, however, unstable, and loses hydrogen bromide very readily, being converted into a yellowish powder which is practically insoluble in ethylic acetate.

*38. "The essential oil of hops. Preliminary notice." By Alfred C. Chapman.

About 80 kilos. of hops, some of which had been grown in Burgundy, some in Alsace, and the remainder in Kent and Sussex, were submitted to steam distillation in quantities of about 1 kilo. at a time.

When the greater part of the oil had been prepared the author was compelled, owing to pressure of other work, to discontinue its examination, and it was placed aside in a well-stoppered bottle, which it filled; at the end of about 10 or 11 months, the remainder of the oil (about 30 c.c.) was prepared, and the whole was then twice steam distilled to free it from resin; about 140 c.c. were obtained. On submitting the oil to distillation it commenced to boil at 170°, the thermometer rapidly rising to 230°, the greater part distilling over between 230° and 270°. After several fractionations, finally over sodium, about 40 c.c. of oil were obtained, boiling between 256° and 261° (uncorr.). This was found, on examination, to be a sesquiterpene, three combustions giving numbers closely agreeing with those required by the formula $C_{15}H_{24}$.

Two vapour density determinations by Hofmann's method gave 6·91 and 7·1, the vapour density required by $C_{15}H_{24}$ being 7·1. The boiling point of the sesquiterpene corrected for the emergent mercurial column was 261—265°. Its relative density was found to be 0·8987 at 15°/15°, and 0·8955 at 20°/20°; when examined in a tube 100 mm. long at 20°, it produced a rotation of 1° 5′ to the right, corresponding to a specific rotatory power of $+1·2°$.

Its index of refraction for the red hydrogen line, hHα was 1·4978, corresponding to a specific refractive energy of 0·555.

Another freshly distilled sample of hop oil which was examined soon after its preparation was found to boil at much lower temperatures, and consisted of lower boiling point terpenes, together with an oxygenated constituent, and contained but little of the sesquiterpene. It is proposed both to continue the study of the sesquiterpene and to examine in detail the other constituents of oil of hops, in the hope of gaining some insight into the nature of the changes which occur during the ageing of the essential oil.

*39. "The sulphides and polysulphides of ammonium." By W. P. Bloxam.

After calling attention to the uncertain state of our knowledge of the changes which solutions of ammonia saturated with hydrogen sulphide undergo when oxidised by exposure to the air, the author describes qualitative experiments from which he infers that in addition to polysulphide such solutions contain *thiosulphate*, but never more than traces of sulphite, and that no sulphate is produced. These conclusions are based on the application of the method of testing recommended by Fresenius (*Qual. Anal.*, Eng. trans. of 15th German ed., p. 193), using cadmium chloride in place of zinc chloride to remove sulphides, as this proved to be a more effective agent, but adding the latter salt as its presence was found to be essential to the production of the coloration characteristic of sulphite. It is pointed out that the presence of excess of ammonia enhances the delicacy of the test for sulphite.

In order to follow with success the changes undergone by solutions of "ammonium sulphide" on oxidation, the author has endeavoured to prepared the various sulphides and polysulphides in a pure state, and describes the results of a large number of experiments. In analysing the solutions of ammonium sulphides, the total sulphur was determined after oxidation by alkaline hypobromite; to determine the polysulphide sulphur, the solutions were boiled with excess of chlorhydric acid to expel sulphuretted hydrogen, and the residual sulphur was then oxidised by hypobromite, &c.; ammonia was estimated by boiling with excess of standardised chlorhydric acid, and then determining the amount of acid in excess.

A concentrated solution of ammonia ($d = 0{\cdot}880$) does not absorb the amount of hydrogen sulphide required to convert the whole of the ammonia into sulphydride, $NH_4{\cdot}SH$, a solution saturated at air temperature taking up only about 75 per cent. of that amount, and having a composition which may be represented by the formula $(NH_4)_2S{\cdot}2NH_4{\cdot}SH$. Less concentrated solutions of ammonia absorb a larger proportion of hydrogen sulphide, a mixture of 1 volume of ammonia solution (0·880) with 4 volumes of water taking up sufficient to form a solution of the composition corresponding with the formula NH_4SH, the strongest solution of this substance which is obtainable containing only about 16 per cent. The author infers, however, from the results obtained on passing hydrogen sulphide into various mixtures of water and ammonia solution cooled with ice water, that the solutions do not progressively take up more hydrogen sulphide as they become weaker, but that the amount absorbed is constant within certain well-defined limits, viz.:—

Ammonia sol.	:	Water.	Composition of sol.
3	:	1	$(NH_4)_2S,4NH_4\cdot SH$
2	:	1	$(NH_4)_2S,8NH_4\cdot SH$
1	:	1	$(NH_4)_2S,8NH_4\cdot SH$
1	:	2	$(NH_4)_2S,18NH_4\cdot SH$
1	:	3	$(NH_4)_2S,18NH_4\cdot SH$
1	:	4	$NH_4\cdot SH$

The author attributes this remarkable behaviour to the actual formation of double sulphides, and states that he has obtained several such in crystals. Thus, by cooling, the solution having a composition corresponding with the formula $(NH_4)_2S\cdot 2NH_4\cdot SH$, crystals of this composition were obtained; whereas a concentrated solution of ammonia, saturated at air temperature with hydrogen sulphide, then cooled to 0° and further saturated with the gas, gave highly hydrated crystals of the formula $(NH_4)_2S\cdot 12NH_4\cdot SH$; and a concentrated solution of ammonia, cooled to 0° and then saturated with hydrogen sulphide, gave well-defined crystals, the composition of which is represented by the formula $(NH_4)_2S\cdot 18NH_4\cdot SH$.

What appears to be ammonium sulphydride, $NH_4\cdot SH$, may be obtained in the solid state by passing the two gases into a vessel surrounded with ice, the hydrogen sulphide being maintained in slight excess; compounds of the type $(NH_4)_2S\cdot xNH_4\cdot SH$ are also formed if the ammonia be in excess,

By exercising great care in adjusting the volumes of the two gases and the rate of flow, operating at 18°, micaceous crystals are obtained, which, when rapidly dissolved in ice-cold water, yield a solution the composition of which sufficiently approximates to that required by the formula $(NH_4)_2S$ to justify the conclusion that they consist of this compound; but if a large excess of ammonia passes through the bottle, a more volatile sulphide is obtained in the form of an oil, which appears to be a compound of the formula $(NH_4)_2S\cdot 2NH_3$.

When an alcoholic solution of ammonia is saturated with hydrogen sulphide, crystalline compounds of the formula $(NH_4)_2S\cdot xNH_4\cdot SH$, containing alcohol of crystallisation, are obtained, the value of x depending on the concentration, as in the case of aqueous solutions.

The formation of definite polysulphides appears to be attended with considerable difficulty; "ammonium sulphide" solutions dissolve, at most, the amount of sulphur required to form a polysulphide of the formula $(NH_4)_4S_9$, and the author is inclined to regard the simpler polysulphides as secondary products resulting from the decomposition of this compound or of analogous lower compounds.

40. "Sarcolactic acid obtained by fermentation of inactive lactic acid." By Percy Frankland, F.R.S., and J. MacGregor, M.A.

The authors have submitted ordinary inactive calcium lactate to partial fermentation, and have recovered from the fermented liquid a lactic acid yielding lævorotatory salts, which was separated from the inactive acid still present by repeated crystallisation of the zinc salts, the zinc salt of the inactive acid being less soluble than that of the active acid.

The specific rotatory power of the active zinc salt was determined in several specimens and for several different concentrations, and results were obtained showing that the rotation on the whole diminishes as the concentration increases and agrees fairly closely with those given by Wislicenus (*Annalen*, **167**, 332).

The identity of the two salts was further established by converting some of the zinc into the calcium salt and determining the specific rotatory power of the latter; the value found ($C = 5{\cdot}79$) was $[\alpha]_D = -5{\cdot}48$, that given by Wislicenus ($C = 5{\cdot}35$) being $[\alpha]_D = -5{\cdot}25$.

The authors hope to render this method available for the preparation of considerable quantities of sarcolactic acid, in the same way as has already been done by one of them in the case of active glyceric acid. In the meantime, it is of interest to note that, as in the case of the fermentation of calcium glycerate, the bacteria attacked by preference the dextrorotatory salt. Similarly, Linossier (*Ber.*, **24**, 660) has shown that *Penicillium glaucum* also first destroys the dextrorotatory lactate.

41. "Hexanitroxanilide." By A. G. Perkin.

It is shown that whereas di- and tetra-nitroxanilide are converted by ammonia into the corresponding nitraniline (*cf. C.S. Trans.*, 1892, 458), hexanitroxanilide not only yields trinitraniline, but also trinitrophenoxamide, $C_6H_2(NO_2)_3{\cdot}NH{\cdot}CO{\cdot}CONH_2$, a substance which crystallises from nitrobenzene in colourless, glistening needles melting at 257°; this compound exhibits acid properties, forming potassium, sodium and ammonium derivatives, *e.g.*, $C_6H_2(NO_2)_3{\cdot}NK{\cdot}C_2O_3NH_2$, which crystallises in red leaflets exhibiting a magnificent golden lustre. When subjected to the action of a cold mixture of nitric and sulphuric acids, trinitrophenoxamide loses the elements of a molecule of ammonia, forming trinitroxanil. Hexanitroxanilide is converted into 1 : 3 : 5-trinitrobenzene by heating it with a mixture of nitric and sulphuric acids; tetranitroxalorthotoluidine in like manner yields 1 : 3 : 5-dinitrotoluene, but the isomeric para-derivative is converted into dinitrobenzoic acid.

Hexanitrocarbanilide has also been prepared by the author; like the corresponding nitroxanilide, it yields red potassium and sodium derivatives.

42. "The constituents of the Indian dye-stuff kamala (I)." By A. G. Perkin.

A description is given of six distinct substances extracted by ether from Kamala—rottlerin, the principal constituent, described by Anderson, in 1855 (*Journ. Chem. Soc.*, 1855, 669); isorottlerin; two resins, one of low, the other of high melting point; a wax, which is possibly cetylic cerotate; and a yellow, crystalline colouring matter present in a minute proportion, the composition of which is yet to be determined.

Rottlerin is best separated from the dye-stuff by means of cold carbon bisulphide, from which it crystallises in thin salmon-coloured plates melting at 191°; its composition is represented by the empirical formula $C_{11}H_{10}O_3$ already assigned to it by Anderson, but it is undoubtedly a substance of high molecular weight. It yields a diacetyl derivative. On boiling it with alkalis, an odour of benzaldehyde is apparent. When oxidised by cold nitric acid, it yields two acids represented by the formulæ $C_{17}H_{14}O_9$ and $C_{17}H_{16}O_9$, while boiling nitric acid converts it into a dibasic acid of the formula $C_{13}H_{10}O_9$.

Isorottlerin closely resembles rottlerin in appearance, but melts at 198—199° and is practically insoluble even in hot carbon bisulphide; moreover, no odour of benzaldehyde is apparent when it is boiled with alkali. It yields the acid of the formula $C_{13}H_{10}O_9$ on oxidation.

The resin of low melting point resembles rottlerin, with which it is evidently closely allied in most of its properties; its composition is represented by the formula $C_{12}H_{12}O_3$; on oxidation, it yields the acid of the formula $C_{13}H_{10}O_9$.

The resin of high melting point is a light-yellow coloured substance represented by the formula $C_{13}H_{12}O_4$, and also resembles rottlerin in many of its properties, being converted into the acid of the formula $C_{13}H_{10}O_9$ when boiled with nitric acid.

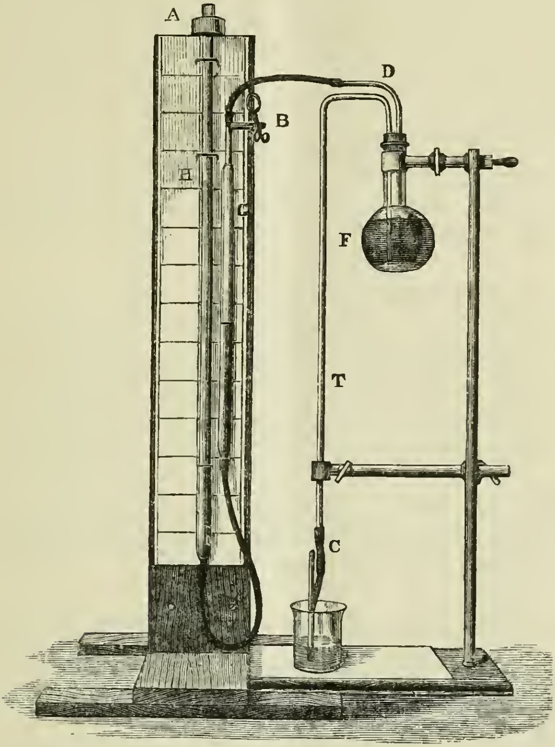
43. "A quantitative method of separating iodine from chlorine and bromine By D. S. Macnair, Ph.D., B.Sc.

The method is based on the fact that when treated with potassium bichromate and concentrated sulphhuric acid, silver iodide is completely converted into silver iodate, whereas silver chloride and bromide are converted into sulphate. Two portions of a solution containing the three halogens are precipitated with silver nitrate: the one precipitate is weighed, the other is heated with the oxidising mixture and the resulting iodate is then reduced by means of sulphurous acid and the iodide is filtered off and weighed. The silver originally present as chloride and bromide contained in the filtrate from the iodide is precipitated and weighed as chloride. The method affords very accurate results.

Addendum.—Since the paper was written, at the suggestion of Dr. Armstrong, I have used a Gooch crucible asbestos filter, instead of paper, and have found it advantageous both as regards speed and accuracy, as it is not necessary to use two portions of the liquid when the chlorine and bromine are to be determined; the precipitate of the mixed haloids may be dried at 120°, weighed, and then treated with sulphuric acid and potassium bichromate as usual, along with the asbestos previously used in filtering. When the oxidation is finished, the solution is diluted and sulphurous acid is added at once, *without* previously filtering off the asbestos, which is collected along with the silver iodide. The weight of the asbestos used in the first filtration is necessarily deducted from that of the silver iodide. It is evident that this asbestos might be removed by filtering before adding sulphurous acid, but I do not recommend this, a ssilver iodate is apt to separate out during the filtration, and unless this be *completely* redissolved—no easy matter—before the addition of sulphurous acid, it will escape reduction and ths results will be unreliable.

44. "Note on a form of burette for rapid titration." By Llewellyn Garbutt, Assistant Master at Winchester College.

The following arrangement will be found extremely convenient in volumetric operations with liquids. The liquid to be used in titrating is contained in the flask F, which may have a capacity ot 300 c.c., and is delivered from a pinch-cock or stop-cock C, at the bottom of the long siphon tube T. The tube D is connected by means of rubber tube to the gas burette G. The side tube B is closed by a pinch-cock, and the graduation of G begins from the bottom. The pressure tube H, which contains water, moves freely upwards, but its downward movement is arrested by the cork A, fixed stiffly to the upper end of the tube H, and normally serving as a support to it. Before beginning the titration the pinch-cock B is opened for a moment to equalise the pressure. The quantity of water in the two tubes is adjusted once for all, so that whenever the pressure is equalised the water in G falls to zero on the scale. The titration is conducted from the cock C in the usual way, and the amount delivered is read by raising H until the liquids are at the same level in both tubes. The parallel lines drawn across the supporting board serve as a guide to the eye. The volume of the liquid delivered can then be read off from the position of the water in G. To begin a new titration, all that is necessary is to let H slide back to its normal position, and open the pinch-cock at B for a moment; the water in G at once falls accurately to zero, and the new titration can be begun. If it is desired to use several different liquids, as many flasks, furnished with siphon and connecting tubes, should be prepared and mounted ready on stands. They can then be connected in a moment with the rubber tube E.



The advantages of this arrangement are—

1. Extreme rapidity and simplicity of adjustment to zero.

2. As much as 300 c.c. of the liquid may be available for a series of titrations.

3. The same burette is used with all liquids, and always starting from zero, so the graduation is constant.

4. If the burette and pressure tube are thoroughly clean, there is little trouble from tears or imperfect meniscus, as only pure water is used in it.

The disadvantages are—

1. The titration must be conducted fairly rapidly (say within 5 or 10 minutes), otherwise changes of temperature and pressure may appreciably affect the volume of the air.

2. The pressure cannot be *perfectly* equalised by means of the sliding tube H. The error of reading from this cause is practically *nil* when F is full, but it might, as an extreme, amount to $\frac{1}{20}$ c.c. when F contains 300 c.c. of air. If it is only desired to to read to $\frac{1}{10}$ c.c., this will not matter much. For greater accuracy the flask must always be kept nearly full.

It is convenient to be able to detach H completely from the board. If the water should get out of adjustment, so that it no longer falls to zero on opening the pinch-cock at B, either a few drops of water may be added or the cork A moved a trifle along the tube H.

45. "The use of sodium peroxide as an analytical agent." By J. Clark, Ph.D.

Experiments are described showing that the sulphur and arsenic in minerals may be rendered soluble by cautiously heating the powdered substance with sodium peroxide, and that the peroxide may, in like manner, be used in estimating chromium in chrome ores and chromium alloys.

An ammoniacal solution of the peroxide may be used in separating manganese from zinc, nickel and cobalt, a single precipitation sufficing in the case of zinc.

46. "Stibiotantalite: a new mineral." By G. A. Goyder.

The note has reference to a mineral from the alluvial tin-field at Greenbushes, Western Australia, the assay values of which varied most unaccountably. It is shown to consist, in the main, of antimony and tantalum oxides and a not inconsiderable proportion of niobic oxide; the amounts found in one sample, for example, were Ta_2O_5 = 51·13, Nb_2O_5 = 7·56, Sb_2O_3 = 40·23.

47. "The colouring matter of Drosera Whittakeri. (II.)" By E. Rennie, M.A., D.Sc.

In a previous communication (*C.S. Trans.*, 1889, 371), the author has described two colouring matters separated from *D. Whittakeri*, which he believed to be derivatives of methylnaphthaquinone. He now confirms the formula $C_{11}H_8O_5$ previously assigned to the less soluble and more abundant constituent; a determination of its molecular weight, by Raoult's cryoscopic method, gave the value 223, the calculated value being 220. When boiled with a solution of sodium carbonate, this substance yields reddish-brown crystals of a monosodium derivative, $C_{11}H_7O_5Na\cdot 2H_2O$, from which the corresponding calcium derivative was prepared; it also yields a disodium derivative. Two yellow crystalline acetyl derivatives were obtained from it, one melting at 154°, the other at 138°, the former being a triacetate, and the latter a compound of the triacetate with acetic acid.

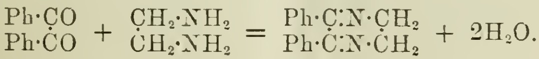
The formula $C_{11}H_8O_4$ previously assigned to the more soluble substance is confirmed; it yields a diacetate. Hitherto this substance has always been obtained in red crystals; in an experiment in which a small quantity was incompletely oxidised, a portion was recovered in the form of yellow crystals melting at 178°, and the author is therefore inclined to think that the pure substance is yellow.

48. "Preparation of mono-, di- and tri-benzylamine." By Arthur T. Mason, Ph.D.

No good method having as yet been published for the preparation of the benzylamine bases, the author has carefully examined the interaction of ammonia and benzyl chloride in alcoholic solution, and finds that it takes place without application of heat and is complete in four or five days. If the theoretical quantity of ammonia be used. tribenzylamine is the principal product, the primary and secondary amines being formed in very small quantity; whereas when a large excess of ammonia (20 mols. to 1 mol. of chloride) is used, mono- and di-benzylamine form the chief products, tribenzylamine appearing in small quantity. The details of the process have been worked out. as also an easy method for the separation of the three amines based on the difference in solubility in water of the chlorhydrides. Dibenzylamine has been prepared for the first time by distillation under reduced pressure: it is a colourless liquid distilling without undergoing the slightest decomposition at 188—189° under 35 mm. pressure.

49. "Piazine (pyrazine) derivatives. (II.)" By Arthur T. Mason, Ph.D.

A continuation of previous researches (*C.S. Trans.*, 1889. 97; *Ber.*, **20**, 267), having reference to the constitution of the compounds resulting from the interaction of ethylenediamine and orthodiketones. The first product from benzil and ethylenediamine is not a true piazine, being easily reconverted into its generators by dilute chlorhydric acid:—



$$\begin{array}{l}Ph\cdot CO\\ Ph\cdot CO\end{array} + \begin{array}{l}CH_2\cdot NH_2\\ CH_2\cdot NH_2\end{array} = \begin{array}{l}Ph\cdot C:N\cdot CH_2\\ Ph\cdot C:N\cdot CH_2\end{array} + 2H_2O.$$

When heated above its melting point, this compound (so calle (2, 3) diphenylpiazine (5, 6) dihydride) yields two true piazine derivatives, which are not resolved into their generators by dilute chlorhydric acid: one of these compounds is isomeric with the (5, 6) dihydride, and is formed by a molecular transformation of that substance: it contains two imide (NH) groups, and is a strong base, being very soluble in dilute chlorhydric acid; it is very easily oxidised, and even when dissolved in chlorhydric acid saturated with carbon dioxide changes spontaneously into the final product of interaction—(2, 3) diphenylpiazine. In the author's opinion, these facts can only be explained by assuming that the true piazines contain a para-bond, thus:—

$$\begin{array}{l}Ph\cdot C{:}N\cdot CH_2\\ Ph\cdot C{:}N\cdot CH_2\end{array},\qquad \begin{array}{l}Ph\cdot C\cdot NH\cdot CH\\ Ph\cdot C\cdot NH\cdot CH\end{array},\qquad \begin{array}{l}Ph\cdot C\cdot N\cdot CH\\ Ph\cdot C\cdot N\cdot CH\end{array}.$$

(5, 6) Dihydride. (1, 4) Dihydride. (2, 3) Diphenylpiazine.

By the interaction of phenanthraquinone and ethylenediamine, only two compounds are obtained, neither of which, however, is reconverted into its generators by chlorhydric acid; they are represented by the formulæ

$$\begin{array}{l}C_6H_4\cdot C\cdot NH\cdot CH\\ C_6H_4\cdot C\cdot NH\cdot CH\end{array}\quad \text{and} \quad \begin{array}{l}C_6H_4\cdot C\cdot N\cdot CH\\ C_6H_4\cdot C\cdot N\cdot CH\end{array}.$$

Phenanthrapiazine (1, 4) dihydride. Phenanthrapiazine.

A series of analogous compounds prepared from other ketones of the phenanthrene (retene and chrysene quinones) series and ethylene- and propylene-diamine are described; their general properties are shown to be similar to those of phenanthrapiazine (1, 4) dihydride and phenanthrapiazine.

50. "Piazine derivatives. (III.)" By Arthur T. Mason, Ph.D., and L. A. Dryfoos, Ph.D.

Details are given of the mode of preparing (2, 3) diphenylpiazine (1, 4) dihydride and of its dibenzoyl and diacetyl derivatives. An addition product obtained by the interaction of the (5, 6) dihydride and hydrogen cyanide in alcoholic solution is described; as this is converted into diphenylpiazine by alcoholic potash, it is to be supposed that the cyanogen radicles are attached to the nitrogen atoms. The constitutional formula of the compound is very probably

$$\begin{array}{l}Ph\cdot CH\cdot N(CN)\cdot CH_2\\ Ph\cdot CH\cdot N(CN)\cdot CH_2\end{array}.$$

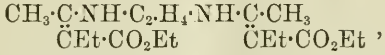
An account is given of a new method of preparing (2, 3) diphenylpiazine, which consists in heating the (5, 6) dihydride with alcoholic potash; a small quantity of a complicated compound—tetraphenyldipiazine—is also formed, which is distinguished by its sparing solubility in the ordinary solvents.

The products of the interaction of dimethoxybenzil or anisil and ethylenediamine, viz., (2, 3) dimethoxyphenylpiazine (5, 6) dihydride and (2, 3) dimethoxyphenylpiazine, are described.

It is shown that, when submitted to the action of potassium cyanide, (2, 3) diphenylpiazine (5, 6) dihydride yields the amide of (2, 3) diphenylpiazinecarboxylic acid, and that the corresponding compound is formed from dimethoxyphenylpiazine dihydride when it is similarly treated.

51. "Condensation products from ethylenediamine and derivatives of acetoacetic acid. (IV.)" By Arthur T. Mason, Ph.D., and L. A. Dryfoos, Ph.D.

The authors describe ethylic ethylene-β-amidomethylcrotonate,



$$\begin{array}{ccc} CH_3{\cdot}\underset{\|}{C}{\cdot}NH{\cdot}C_2{\cdot}H_4{\cdot}NH{\cdot}\underset{\|}{C}{\cdot}CH_3 \\ CEt{\cdot}CO_2Et \qquad\qquad CEt{\cdot}CO_2Et \end{array},$$

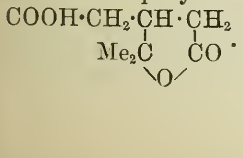
obtained by the interaction of ethylic methylacetoacetate and ethylenediamine; and also the corresponding compounds from ethylic ethylacetoacetate and methylic acetoacetate.

52. "Studies of the oxidation products of turpentine." By S. B. Schryver, Ph.D., B.Sc.

The author finds that on oxidising turpentine with chromic mixture, besides terebic and terpenylic acids, a third acid is obtained having the same composition as camphoronic acid, $C_9H_{14}O_6$, but differing from it in electric conductivity (0·0102 instead of 0·0175); it is contained in the mother liquors from which the other acids have been separated, and is isolated through the agency of an insoluble lead salt. The crude acid fused at 125—160°, but after repeated crystallisation from nitric acid at 135—137°.

With the object of determining the constitution of terpenylic acid, attempts were made to synthesise various heptolactones: eventually that prepared from the methylisopropyllactic acid of the formula $PrCMe(OH){\cdot}CH_2{\cdot}COOH$ was found to be identical with the lactone prepared from teracrylic acid.

On reducing terpenylic acid with iodhydric acid, an acid was obtained which is shown to be identical with β-isopropylglutaric acid prepared synthetically by condensing isobutaldehyde and ethylic malonate, combining the product with ethylic sodiomalonate, and hydrolysing the resulting tetrethylic salt. The conclusion is arrived at that terpenylic acid is to be represented by the formula



$$\begin{array}{l} COOH{\cdot}CH_2{\cdot}\underset{|}{C}H{\cdot}\underset{|}{C}H_2 \\ \qquad\quad Me_2C \quad CO \\ \qquad\qquad\; \diagdown O \diagup \end{array}.$$

53. "Addendum to note on the nature of depolarisers." By Henry E. Armstrong.

I am induced to somewhat extend my recent note on depolarisers in order that the argument there made use of in considering the dissolution of metals such as magnesium in nitric acid may be clearly understood and its consequences more fully realised.

It is one of the most noteworthy features of such interactions that when reduction is carried beyond the nitric oxide stage, it invariably proceeds to ammonia, and gives rise to a variety of products: so that whereas neither nitrous oxide nor nitrogen is evolved when metals such as silver and mercury are dissolved, these two gases are always obtained when more active metals are the agents. From this it would appear that there is a limit of (?) electromotive force which must be exceeded if it be desired to extend the reduction beyond the stage involving the formation merely of nitrogen dioxide and monoxide.

A somewhat similar case is presented by the behaviour of sulphuric acid solutions on electrolysis. Whereas, besides hydrogen, only oxygen is obtained under certain conditions, under others ozone, persulphuric acid and hydrogen peroxide are also produced. This apparently is a phenomenon of the same order, but in a measure the converse of that presented by nitric acid, as oxygen—not hydrogen—is the active substance. Judging from McLeod's observations (*C.S. Trans.*, 1886, 591), it is clear that "current density" is an all-important factor in determining "peroxidation," but it remains to be determined whether it is the sole factor: the individual influence of electromotive force, of current strength and of current density, in fact, all require careful study in this as in many other cases of electrolysis; undoubtedly much depends on the concentration of the acid. The peroxidation may be regarded as the outcome of oxygen depolarisation, effected apparently in two ways: part of the oxygen becoming affixed to sulphuric acid, persulphuric acid is formed, which in part gradually undergoes hydrolysis, affording hydrogen peroxide—a non-electrolytic change; while another part serves as oxygen depolariser, affording ozone. On this assumption, ozone is not the product of the fortuitous concourse of three oxygen atoms, but of the interaction of oxygen atoms in circuit with persulphuric acid; and if this be the origin of electrolytic ozone, it appears not improbable that the oxidation of phosphorus, which is attended by the formation of ozone, will also be found to involve the formation of a peroxide hitherto undiscovered.

In the case of a metal such as magnesium dissolving in considerable excess of nitric acid, if a plate be imagined to be undergoing attack and conversion into nitrate at any one point, the displaced hydrogen may, it would seem, "travel along" a very large number of paths to other points on the plate capable of acting as negative pole and of there meeting with nitric acid in sufficient amount to oxidise it, and it is scarcely conceivable, therefore, that it should escape if the nitric acid act directly as depolariser. It is also difficult to understand why one substance, an electrolyte, should act in two ways in the same circuit, and the difficulty appears to be equally great whether any form of Grothus' hypothesis, or a dissociation hypothesis, be adopted in explanation of electrolysis. But these difficulties seemingly disappear if—as previously suggested—the active depolariser be a nitrous compound or derivative; perhaps, at all events, at the initial stage, nitrogen dioxide. Moreover, it would appear to be possible in this manner to account also for the extension of the reduction to ammonia: in the case of a metal like silver the amount of depolariser must always tend to reach a maximum value depending on the extent to which the reversible interchange expressed by the equation $NO + 2HNO_3 = 3NO_2 + OH_2$ is limited by the concentration and temperature; but it is limited by these conditions alone. In the case of more active metals, it appears probable that the nitric oxide also functions as depolariser and is reduced to hydroxylamine and ultimately to ammonia. If such an action take place, it follows (from Ohm's law) that the more active the metal the more rapidly will hydrogen be displaced by it, giving greater opportunity therefore for nitric oxide to undergo reduction and leading to the production of an increased proportion of products of extended reduction. Any circumstance which would tend to diminish the proportion of nitrogen dioxide relatively to monoxide present in solution would, therefore, promote the formation of such products, and, in point of fact, Acworth and I have noticed, even in the case of copper, that when the metal is dissolved in diluted nitric acid, it appears to be more "active," *i.e.*, to furnish a larger proportion of products of extended reduction, than when more concentrated acid is used: as the presence of water must obviously favour the reversal of the interchange expressed by the equation $NO + 2HNO_3 = 3NO_2 + H_2O$, so that weaker would potentially contain a larger proportion of monoxide than stronger solutions of nitric acid, these observations would appear to be in harmony with the hypothesis here advocated. There is no evidence, be it remarked, that hyponitrous acid can be formed in acid solution, *i.e.*, by direct reduction of nitric or even of nitrous acid, and the whole of the nitrous oxide which is evolved when metals are dissolved in nitric acid may result from the interaction of nitrous acid and hydroxylamine. That reduction invariably extends to ammonia whenever hydroxylamine is formed is probably a consequence of the extreme readiness with which hydroxylamine is itself reduced, so that, in fact, when reduction once proceeds beyond the nitric oxide stage, it is to be supposed that there are necessarily a number of competing depolarisers present in solution—nitrogen dioxide and monoxide and hydroxylamine (and perhaps others), none of which, however, are electrolytes in the sense in which the term is ordinarily understood. And here it may be pointed out that the fact that a nitrate may be reduced in alkaline solution by sodium amalgam, or aluminium, or zinc, is no argument against the conclusion above arrived at that probably nitric acid does not directly act as depolariser, as in these cases the alkaline solution appears to be the electrolyte and the nitrate merely the depolariser—so that the nitrate does not act in two ways. As nitrates may be wholly converted into ammonia by reducing an alkaline solution, it would seem probable that in such cases hydroxylamine is not an intermediate product, as nitrogen is obtained on boiling an alkaline solution of this substance.

The argument here made use of would appear also to afford an explanation of the effect produced by varying the electromotive force, *i.e.*, by metals of different degrees of "activity": as increase of electromotive force, other conditions remaining unchanged, would increase the current strength and consequently the rate of change; and, as indicated above, an increase in the rate of change would doubtless involve an increase in the amount of products of extended reduction.

It remains to be pointed out that the objection made to the assumption that nitric acid can act in two ways is equally applicable to the case of sulphuric acid; in other words, that it is not likely that sulphuric acid would act as electrolyte and as oxygen depolariser. It becomes necessary, therefore, to reconsider the manner in which solutions of this acid undergo electrolysis. On the one hand it is conceivable that the water molecule alone suffers partition, not the sulphuric acid (H_2SO_4) molecule, as commonly supposed, and that under certain conditions the latter takes a direct part in the change, becoming oxidised; but this does not appear to be probable, especially as there is reason to believe that the acid in conjunction with water actually functions as electrolyte. An alternative assumption would be that the immediate product has been overlooked, and it can scarcely be gainsaid that there is much evidence in favour of this view. It is not improbable that the first products of electrolysis are hydrogen and *persulphuric* acid; it may be supposed that under "ordinary" circumstances this latter substance is resolved at the electrode surface into oxygen and sulphuric acid, but when the electrode surface is small much escapes unchanged, this being especially the case when the electrolyte is a somewhat concentrated acid—a condition which in itself favours the survival of persulphuric acid. Not only do recent observations on the electrolysis of various sulphates support this contention, but it would seemingly also serve to explain the extraordinary character of the curve representing the change in conductivity of solutions of sulphuric acid on dilution.

54. "The molecular complexity of liquids." By William Ramsay, Ph.D., F.R.S., and John Shields, Ph.D., D.Sc.

From the ascent of a liquid in a capillary tube of known diameter and its relative density, the surface tension of the liquid may be calculated. The molecular volume of a liquid, at any temperature, is proportional to the number of molecules contained in unit volume at that temperature; and the two-thirds root of the number representing the molecular volume is proportional to the number of molecules distributed in unit surface, with the proviso that the mean distance between 2 mols. at the surface is equal to that between any 2 mols. in the interior. Multiplying the number representing surface tension by that representing molecular surface, the product may be termed "molecular surface energy." By stating surface tension in degrees, and molecular surface in square centimetres, the product is expressed in ergs, and may be defined as the work required to produce or to extend a surface on which equal numbers of molecules lie.

This energy is *nil* at the critical temperature of the liquid, for there is no surface. It increases with fall of temperature, and after about 20° below the critical temperature, the rate of increase is practically a linear function of the temperature. The equation which exhibits this relation is

$$\gamma(\mathrm{M}v)^{\frac{2}{3}} = k(\tau - d),$$

where the letters have the following definitions:—

γ, surface tension,
M, molecular weight,
v, specific volume,
k, a numerical constant,
τ, temperature measured downwards from the critical temperature,

d, being a numerical constant equal to about 6.

This equation is analogous to that which expresses volume energy in its relation to heat, viz., $pv = \mathrm{R}\mathrm{T}$.

As a gas is said to be normal if, when v expresses the volume of its molecular weight taken in grams, and p is measured in atmospheres, R is constant between various limits of temperature, so a liquid may be said to be normal, *i.e.*, to be composed of molecules of no greater degree of complexity than those which form its gas, if the value of k is constant between various limits of temperature. This affords a means, therefore, of investigating the molecular weights of liquids as such, and it is the first colligative property of liquids which has been discovered.

In all 57 liquids have been investigated. They divide themselves into two groups: those of which the molecules are simple (36 in number), and those which, in the liquid state, consist of molecules composed of several gaseous molecules coalesced to form a complex. To the latter class belong the alcohols, the acids, water, phenol, and three others, nitroethane, acetonitrile and acetone.

It is remarkable that, so far as our experiments have gone, no liquid shows a greater molecular complexity than that in which the molecular weight of the gas is multiplied by the factor 4. Water at 0° has approximately the formula H_8O_4, *i.e.*, $(H_2O)_4$; the degree of complexity, however, is altered by rise of temperature, and the complex molecules gradually dissociate into more simple groups.

A determination of molecular surface energy also permits of a close estimate of the critical temperatures of "normal" liquids. The numbers representing these important data are given in the complete memoir.

55. "The preparation of active amyl alcohol and active valeric acid from fusel oil." By W. A. C. Rogers.

The author has prepared the alcohol by a modification of Le Bel's method communicated to him by Professor Odling and Mr. Marsh, which consists in heating the alcohol with a fuming aqueous solution of hydrogen chloride in closed tubes at 100°, the treatment being repeated until the rotatory power of the product reached a maximum. Finally, from 16·2 litres of purified fusel oil, he obtained 250 c.c. of an alcohol rotating $-8° \; 30'$ per 200 mm. at 22° (or $[\alpha]_D = -5{\cdot}2°$). By oxidising this alcohol, a valeric acid was obtained rotating 26° per 200 mm. at 22° ($[\alpha]_D = 13{\cdot}9°$). The values thus obtained are practically identical with those given by Guye and Chavanne in a recent paper.

RESEARCH FUND.

A donation of £100 to the Research Fund has been received from Mr. L. Mond, F.R.S., by the Treasurer since the meeting of the Society.

The following is the text of the address presented to Sir John Lawes, Bart., &c., and Dr. Gilbert, on July 29th, on the occasion of the Rothamsted Jubilee :—

We, the President and Officers of the Chemical Society of London, on behalf of the Council and Fellows generally, desire on this occasion to express our sense of the extraordinary value of your labours in the field of agricultural science, our admiration of your researches, and our gratitude for the immense number of exact data which you have placed at the disposal of chemists.

Few men have been able to conduct experimental researches during so long a period, and there is no parallel in the history of science to your achievement in carrying on a single research without interruption during a period of over 50 years. The plan laid down at its commencement has throughout been most rigidly adhered to, which is evidence of the skill originally displayed in its inception, and gives to your work its peculiar value.

While affording guidance to the agriculturist, your researches have elicited information which will ever serve as the foundation of a truly scientific knowledge of the correlation of plant growth and manurial constituents of the soil, and will be of the utmost value in all discussions of the chemistry of plant life. Your researches on the feeding of animals, in like manner, are not only of practical importance, but also shed much light on the processes of animal life.

Great, however, as is the actual value to agriculture and agricultural science of your work, the example your single-minded devotion to the cause of scientific truth and research has afforded to the world is unquestionably to be regarded as of far greater value. Yours is the model of all agricultural experimental stations, and the methods that you have introduced are everywhere regarded as classical.

The rare and enlightened munificence which has led the one of you to institute and maintain such a series of enquiries having been supplemented by a provision for the future conduct of the experiments in order especially to make it possible to deal with the great question of the ultimate exhaustion of the soil, the debt of gratitude which science owes to the founder of the Rothamsted experimental station is extended into the distant future.

It is, consequently, with a full sense of the inadequacy of our expressions that we to-day offer to you our heartfelt thanks and our warmest congratulations on your having been able to achieve results of such magnitude and importance.

The following "Circular concerning the Hodgkins Fund Prizes" has been communicated to the Society by the Secretary of the Smithsonian Institution :—

In October, 1891, Thomas George Hodgkins, Esq., of Setauket, New York, made a donation to the Smithsonian Institution, the income from a part of which was to be devoted "to the increase and diffusion of more exact knowledge in regard to the nature and properties of atmospheric air in connection with the welfare of man."

With the intent of furthering the donor's wishes, the Smithsonian Institution now announces the following prizes to be awarded on or after July 1, 1894, should satisfactory papers be offered in competition :—

1. A prize of $10,000 for a treatise embodying some new and important discovery in regard to the nature or properties of atmospheric air. These properties may be considered in their bearing upon any or all of the sciences, *e.g.*, not only in regard to meteorology, but in connection with hygiene, or with any department whatever of biological or physical knowledge.

2. A prize of $2,000 for the most satisfactory essay upon—

   (*a*) The known properties of atmospheric air considered in their relationships to research in every department of natural science, and the importance of a study of the atmosphere considered in view of these relationships.

   (*b*) The proper direction of future research in connection with the imperfections of our knowledge of atmospheric air, and of the connections of that knowledge with other sciences.

The essay, as a whole, should tend to indicate the path best calculated to lead to worthy results in connection with the future administration of the Hodgkins foundation.

3. A prize of $1,000 for the best popular treatise upon atmospheric air, its properties and relationships (including those to hygiene, physical and mental). This essay need not exceed 20,000 words in length ; it should be written in simple language, and be suitable for popular instruction.

4. A medal will be established, under the name of "The Hodgkins Medal of the Smithsonian Institution," which will be awarded annually or biennially, for important contributions to our knowledge of the nature and properties of atmospheric air, or for practical applications of our existing knowledge of them to the welfare of mankind. This medal will be of gold, and will be accompanied by a duplicate impression in silver or bronze.

The treatises may be written in English, French, German or Italian, and should be sent to the Secretary of the Smithsonian

Institution, Washington, before July 1, 1894, except those in competition for the first prize, the sending of which may be delayed until December 31, 1894.

The papers will be examined, and prizes awarded, by a committee to be appointed as follows :—One member by the Secretary of the Smithsonian Institution, one member by the President of the National Academy of Sciences, one by the President, *pro tempore*, of the American Association for the Advancement of Science ; and the committee will act together with the Secretary of the Smithsonian Institution as member, *ex officio*. The right is reserved to award no prize if, in the judgment of the committee, no contribution is offered of sufficient merit to warrant an award. An advisory committee of not more than three European men of science may be added at the discretion of the Committee of Award.

If no disposition be made of the first prize at the time now announced, the Institution may continue it until a later date, should it be made evident that important investigations relative to its object are in progress, the results of which it is intended to offer in competition for the prize. The Smithsonian Institution reserves the right to limit or modify the conditions for this prize after December 1, 1894, should it be found necessary. Should any of the minor prizes not be awarded to papers sent in before July 1, 1894, the said prizes will be withdrawn from competition.

A principal motive for offering these prizes is to call attention to the Hodgkins Fund, and the purposes for which it exists, and accordingly this circular is sent to the principal universities, and to all learned societies known to the Institution, as well as to representative men of science in every nation. Suggestions and recommendations in regard to the most effective application of this fund are invited.

It is probable that special grants of money may be made to specialists engaged in original investigation upon atmospheric air and its properties. Applications for grants of this nature should have the indorsement of some recognised academy of sciences, or other institution of learning, and should be accompanied by evidences of the capacity of the applicant, in the form of at least one memoir already published by him, based upon original investigation.

To prevent misapprehension of the founder's wishes, it is repeated that the discoveries or applications proper to be brought to the consideration of the Committee of Award, may be in the field of any science or any art without restriction ; provided only that they have to do with "the nature and properties of atmospheric air in connection with the welfare of man."

Information of any kind desired by persons intending to become competitors will be furnished on application.

All communications in regard to the Hodgkins Fund, the Hodgkins Prizes, the Hodgkins Medals, and the Hodgkins Fund Publications, or applications for grants of money, should be addressed to S. P. Langley, Secretary of the Smithsonian Institution, Washington, U.S.A.

ADDITIONS TO THE LIBRARY.

I. *Donations.*

Traité pratique de calorimétrie chimique, par M. Berthelot. Paris 1893. From the Author.

Royal Society of London. Philosophical Transactions. Vol. 130 (1840). 4to. (To complete set.) From G. T. Holloway, Esq.

II. *By Purchase.*

Lehrbuch der physiologischen Chemie, von R. Neumeister. Erster Theil: Die Ernährung. Jena 1893.

Anleitung zur Harnanalyse, von W. F. Loebisch. Wien und Leipzig 1893.

Die Wirkungsweise der Rectificir- und Destillir-Apparate, von E. Hausbrand. Berlin 1893.

Procentische Zusammensetzung und Nährgeldwerth der menschlichen Nahrungsmittel. Graphisch dargestellt, von J. König. 6ste Auflage. Berlin 1893.

Die Leim- und Gelatine-Fabrikation, von F. Dawidowsky. Wien Pest und Leipzig 1893.

L'alimentation de l'homme et des animaux domestiques, par L. Grandeau. Tome I: la nutrition animale. Paris 1893.

Molecularkräfte, von E. Seelig. 2te Auflage. Berlin 1893.

Handbuch der Chemischen Technologie, von F. Fischer (Zugleich 14te Auflage von Wagner's Chemischen Technologie). Leipzig 1893.

Traité pratique d'analyse chimique et de recherches toxicologiques, par G. Guérin. Paris 1893.

Die Verwerthung des Holzes auf chemischen Wege, von J. Bersch. Wien, Pest und Leipzig 1893.

Royal Society of London. Philosophical Transactions. Vols. 43—129 (1744—1839). Indexes—Vols. 1—70 (1655—1780), and 71—110 (1781—1820). 95 vols. 4to.

Lehrbuch der Allgemeinen Chemie, von W. Ostwald. Zweite Auflage. Band II, 1. Chemische Energie. Leipzig 1893.

Das Kupfer, von Standpunkte der gerichtlichen Chemie, Toxicologie und Hygiene, von A. Tschirch. Stuttgart 1893.

Éléments de Cristallographie physique, par C. Soret. Genève et Paris 1893.

Theoretische Chemie, vom Standpunkte der Avogadro'schen Regel und der Thermodynamik, von W. Nernst. Stuttgart 1893.

Entwickelungsgeschichte, und kritisch-experimenteller Vergleich der Theorien über die Natur der sogenannten Knallsäure und ihrer Derivate, von R. Scholl. München und Leipzig 1893.

Die Thermodynamik in der Chemie, von J. J. van Laar. Amsterdam und Leipzig 1893.

HARRISON AND SONS, PRINTERS IN ORDINARY TO HER MAJESTY, ST. MARTIN'S LANE.

Issued 16/11/1893.

PROCEEDINGS
OF THE
CHEMICAL SOCIETY.

No. 128. Session 1893–94.

The following are abstracts of papers received during the vacation, and published in the Transactions :—

56. "Peri-derivatives of naphthalene." By R. Meldola, F.R.S., and F. W. Streatfeild. (Trans., 1893, 1054.)

A description is given of the preparation of 1 : 1′-, or peri-nitronaphthylamine by nitrating α-naphthylamine in presence of sulphuric acid, and of the preparation from this compound of benzylidene-1 : 1′-nitronaphthylamine, 1 : 1′-nitrobromonaphthalene, 1 : 1′-bromonaphthylamine, 1 : 1′-bromonaphthol and 1 : 1′-dibromonaphthalene.

57. "Note on lead tetracetate." By A. Hutchinson, M.A., Ph.D., and W. Pollard, B.A. (Trans., 1893, 1136.)

It is shown that the compound which crystallises from a solution of red lead in glacial acetic acid, described by Jacquelain, in 1851, is *lead tetracetate*, $Pb(C_2H_3O_2)_4$. A corresponding propionate has been obtained. On adding ammonium chloride to a solution of the tetracetate in chlorhydric acid, a precipitate of the characteristic double salt of ammonium chloride and lead tetrachloride is produced.

58. "Resolution of lactic acid into its optically active components." By T. Purdie, Ph.D., B.Sc. (Trans., 1893, 1143.)

Inactive lactic acid has already been resolved into its active components by two of the three general methods discovered by Pasteur, namely, by selective fermentation and by crystallisation of salts of the alkaloids. The author finds that the third method, that of spontaneous resolution by crystallisation, can also be applied with success.

In the course of an investigation on the resolution of lactic acid into its active components by crystallisation of the strychnine salts (Purdie and Walker, Trans., 1892, 754) an active zinc ammonium lactate was encountered, which possessed in a marked degree the property of forming supersaturated solutions when dissolved in a syrup of active ammonium lactate, and of separating from these solutions in comparatively large, well-defined crystals. It was also observed that a strong solution of ordinary ammonium lactate dissolves large quantities of ordinary zinc lactate, forming a syrup from which an inactive zinc ammonium lactate does not at once crystallise, but which readily deposits zinc lactate when slightly diluted. These observations suggested the idea that possibly the active double salts might be present in such a solution in a state of supersaturation, and that they might be separately crystallised from it under suitable conditions of temperature and concentration by adding the proper crystalline nuclei.

It is found that by heating a solution containing certain definite proportions of ammonium lactate, zinc lactate and water and then cooling, a supersaturated solution is obtained, from which either of the active salts or the inactive salt can be separated at will by adding traces of the respective salts as nuclei. By alternately dropping into such a solution dextrogyrate and lævogyrate nuclei, and adding fresh inactive zinc lactate to the exhausted mother liquor, it is possible to obtain successive crops of the oppositely active salts in quantity. By recrystallisation, products are readily obtained containing over 90 per cent. of the active substances. The admixture of inactive salt can be eliminated by crystallisation of the zinc lactate prepared from the double salts. Determinations of the specific rotations of the zinc lactates thus obtained gave numbers agreeing with those given by Wislicenus for zinc sarcolactate at similar concentration. When equal quantities of 8 per cent. solutions of the oppositely active zinc ammonium salts are mixed, inactive zinc lactate is precipitated. The inactive zinc ammonium salt was also prepared, and was found to have the composition represented by the formula $Zn(C_3H_5O_3)_2 \cdot NH_4 \cdot C_3H_5O_3 \cdot 3H_2O$, while that of the active salts is $Zn(C_3H_5O_3)_2 \cdot NH_4 \cdot C_3H_5O_3 \cdot 2H_2O$. The salts also differ considerably in properties.

59. "The colouring principles of Rubia sikkimensis." By A. G. Perkin, and J. J. Hummel. (Trans., 1893, 1157.)

The authors have separated both purpurin and munjistin or purpuroxanthincarboxylic acid from this root; they point out that the results show that it is nearly identical as regards colouring principles with the closely allied *Rubia munjistin*.

60. "The colouring and other principles contained in chay root." By the same. (Trans., 1893, 1160.)

Chay root is the root of *Oldenlandia umbellata*, and is used as a dye-stuff in India; a large number of distinct products were isolated by extracting it either with an aqueous solution of sulphurous acid, or with lime water, alcohol and other solvents, viz., two substances of the formula $C_{16}H_{12}O_5$, both of which are shown to be anthragallol-dimethyl ethers; a monomethyl ether of alizarin crystallising in orange needles melting at 178—179°; a resinous yellow substance, possibly an isomeric methyl ether of alizarin in an impure form; metahydroxyanthraquinone; a yellow substance melting at 141°, which yields alizarin when heated with sulphuric acid; ruberythric acid; rubichloric acid; alizarin; a wax of the formula $(C_{10}H_{18}O)_2$, melting at 87—88°; and cane sugar.

61. "Phenylnaphthalenes. I. α-Phenylnaphthalene." By F. D. Chattaway, B.A. (Trans., 1893, 1185.)

It is shown that α-phenylnaphthalene can be synthesised in several ways, but that the yield in all cases is unsatisfactory. The best method is by the action of α-chloronaphthalene on benzene in the presence of anhydrous aluminium chloride. α-Phenylnaphthalene is obtained as a thick, oily liquid which solidifies on long standing, affording a fatty-looking mass without definite crystalline form. It boils at 324—325°, and is readily soluble in alcohol, ether and benzene, but cannot be obtained crystalline from these solutions, being deposited on evaporating them in oily drops. It volatilises with steam, and possesses a peculiar odour resembling both naphthalene and diphenyl.

62. "The vapour pressures, molecular volumes and critical constants of ten of the lower ethereal salts of acids of the acetic series." By Sydney Young, D.Sc., F.R.S., and G. L. Thomas, B.Sc. (Trans., 1893, 1191.)

The authors' chief object was to ascertain how far the generalisations of Van der Waals regarding "corresponding" temperatures, pressures and volumes are true for the members of a group of allied compounds. It has already been shown by one of them that the generalisations hold good, with a close approximation to accuracy, in the case of the four mono-haloid derivatives of benzene, but that when compounds of different chemical character are compared much greater deviations are to be observed, more especially as regards the absolute temperatures (boiling points) at corresponding pressures. It has also been shown that among the substances so far studied the deviations are greatest in the case of acetic acid and the alcohols, and it becomes, therefore, of additional interest to examine the behaviour of the salts formed by the interaction of the fatty acids and alcohols. The critical and other constants of a number of these have been determined by several observers, but the results are far from concordant, owing, probably, to imperfect purification of the substances examined. Two samples of each ethereal salt were employed: one was prepared from the acid or anhydride and the alcohol; the other was obtained from Kahlbaum. All were carefully purified, and their purity was proved both by the constancy of their boiling points and by the agreement between the boiling points, relative densities and critical temperatures and pressures of the two samples.

The investigation shows that although the results obtained with the ten compounds are in fair agreement with the generalisation of Van der Waals—in close agreement so far as the molecular volumes of liquid are concerned—yet the deviations observed are related to their composition.

The ratios of the absolute temperatures to the absolute critical temperatures at any series of corresponding pressures are clearly dependent on the molecular weights, though this is apparently not the case with the ratios of the molecular volumes of either liquid or saturated vapour to the critical volumes.

The composition of the isomeric ethereal salts appears, however, to influence all the ratios, those for the formates being lowest when the absolute temperatures or volumes of saturated vapour are compared and highest in the case of the volumes of liquid. The ratios for the acetates, on the other hand, are highest in the case of the absolute temperatures and of the volumes of saturated vapour, and lowest for the volumes of liquid.

The presence of the iso-group in methylic isobutyrate appears to have a distinct influence on the ratios. The ratios of the actual critical densities to the theoretical densities (for a perfect gas) show a maximum variation of 2 per cent.; the mean value, 3·91, is somewhat higher than that (3·76) for the majority of substances previously studied; it is, however, lower than for the alcohols and for acetic acid.

The ratios of the absolute temperatures and of the volumes of liquid and saturated vapour at corresponding pressures to the critical constants, also the values of PV/T at the critical points, are compared with those of the substances previously studied, and it is found that the ethereal salts form a separate group.

The 22 compounds for which data are available fall into four groups, (1) the ethereal salts, (2) the alcohols—methyl alcohol being especially abnormal, (3) acetic acid, (4) ether, benzene and its haloid derivatives, carbon and tin tetrachlorides.

63. "The fermentation of dextrose, rhamnose, and mannitol by a lævolactic ferment." By George Tate, Ph.D.

In studying the micro-organisms that attack ripe pears, the author has had occasion to isolate an organism that under aërobic conditions brings about lævolactic fermentations of the hexoses dextrose, mannose and galactose and also of mannitol, but an inactive lactic fermentation of the methylpentose rhamnose (isodulcite).

The products of the fermentation of dextrose, mannitol and rhamnose have been quantitatively determined: 9 molecules of dextrose are found to yield 2 molecules of alcohol, 1 of succinic acid, 7 to 8 of lævolactic acid, and smaller molecular proportions of formic and acetic acids.

Mannitol yields the same products, but in different proportions, there being a greater yield of alcohol and slightly greater yield of lævolactic acid.

Neither alcohol nor formic acid was found among the products of the fermentation of rhamnose; 9 molecules of this sugar afforded approximately 5 molecules of acetic acid and 4 molecules of optically inactive lactic acid.

The action of the organism as a lævolactic ferment of dextrose, was found to be unchanged after cultivating the parent cells in fluids containing rhamnose, inactive acid being formed.

The organism which is referred to as a lævolactic ferment from its action upon the typical sugar dextrose belongs to the class of ascobacteria, and can develop so as to produce two forms of growth, widely differing in macroscopic appearance—one in which rods and cocci predominate, a second in which the organism propagates as an ascobacterium.

64. "Derivatives of quinone containing halogens. Part III. Derivatives of quinhydrone." By Arthur R. Ling and Julian L. Baker. (Trans., 1893, 1314.)

Quinhydrone melts at 170—171°. The authors have obtained a compound having the composition of a *monochloroquinhydrone*, which melts at 145°, by gently heating a solution of quinone and monochloroquinol in chloroform; under somewhat similar circumstances, Clark (*Amer. Chem. J.*, **14**, 574) obtained a small amount of quinhydrone. They have also obtained an isomeric compound melting at 132—133° by evaporating an ethereal or alcohol solution of quinol and monochloroquinone. When either of these isomerides is boiled with light petroleum they dissociate, and their constituents then interact, giving rise to dichloroquinhydrone, which is dissolved by the light petroleum, and quinhydrone, which remains undissolved.

Dichloroquinhydrone, $C_6H_3ClO_2,C_6H_3Cl(OH)_2$, is obtained by mixing solutions of monochloroquinone and monochloroquinol, and also by partially oxidising a solution of monochloroquinol with ferric chloride. It crystallises from water in dark violet needles containing one molecular proportion of water, melting at 70—72°; these are rendered anhydrous when kept over concentrated sulphuric acid and then melt at 93—94°.

Tetrachloroquinhydrone, $C_6H_2Cl_2O_2,C_6H_2Cl_2(OH)_2 + 2H_2O$, was described by Städeler, in 1849. It is obtained in the form of dark violet needles by triturating paradichloroquinone and paradichloroquinol with water, and also by partially oxidising a solution of paradichloroquinol; the authors find that it melts between 105° and 140°, but has no definite melting point. They confirm Städeler's observations that it loses its water of crystallisation when kept over concentrated sulphuric acid, becoming light yellow; the crystalline form of the anhydrous compound appears to be the same as that of the hydrated compound. An isomeride is obtained when metadichloroquinol and an excess of metadichloroquinone are boiled with a mixture of benzene and light petroleum; it separates from the filtrate in long, brown, prismatic needles, and melts at 135°.

Hexachloroquinhydrone.—A substance of the composition $C_{12}H_4Cl_6O_4 + \frac{1}{2}H_2O$ is obtained by triturating trichloroquinone and trichloroquinol with water; it melts at 115—117° and does not alter in weight when kept over concentrated sulphuric acid.

The authors failed to obtain octochloroquinhydrone, and conclude, from numerous experiments which are described, that this compound is non-existent.

Dibromoquinhydrone, $C_6H_3BrO_2,C_6H_3Br(OH)_2$, crystallises from water in anhydrous, dark, bronze-coloured needles and melts at 98°.

Tetrabromoquinhydrone is obtained by boiling an aqueous solution of paradibromoquinol with an excess of paradibromoquinone; it separates, when the filtrate is rapidly cooled, in dark violet needles of the composition $C_6H_2Br_2O_2,C_6H_2Br_2(OH)_2 + 2H_2O$, and melts at 145—150°. It loses its water of crystallisation and becomes light-coloured when kept over concentrated sulphuric acid.

Dichlorodibromoquinhydrone, prepared from paradichloroquinone and paradibromoquinol, crystallises from water in bluish-black needles containing two molecular proportions of water; it melts at 130—135° and loses its water of crystallisation, becoming light-yellow coloured when kept over concentrated sulphuric acid. An isomeride is obtained from paradibromoquinone and paradichloroquinol; it resembles the last-described compound and becomes pale brownish-yellow, losing its water of crystallisation, when kept over concentrated sulphuric acid.

November 2nd, 1893. Dr. Armstrong, President, in the Chair.

Messrs. Edmund Lamb, James A. Audley, Henry Bailey and Charles Mills were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Frederick Edmund Bowman, Ash Leigh, Bowdon, Cheshire; Henry Fielden Briggs, Roseneath, Torquay; Frank Browne, Government Civil Hospital, Hong Kong; John Dixon Brunton, Wire Mill, Musselburgh; Charles March Caines, 11, Clockhouse Road, Beckenham, Kent; Thomas Petson Carswell, 369, Scotswood Road, Newcastle-on-Tyne; Harry J. Chaney, 29, Chalcot Crescent, Regent's Park, London; Allan Thomas Cocking, 39, Lister Street, Rotherham; John A. Craw, 2, Millgate, Cupar Fife; Charles Sordes Ellis, 17, Bloomsbury Square, W.C.; Alexander M. Forrester, 22, Scotia Street, Glasgow; Henry Garnett, 2, Bartholomew Villas, Kentish Town, N.W.; William Hotton Grieve, 226, Friern Road, East Dulwich; Harry Edwin Hadley, The School of Science, Kidderminster; Henry Ormsby Hale, Oundle School, Northamptonshire; Harold Harris, Denmark House, Tuffley Avenue, Gloucester; William Hesketh, B.A., School House, Ferriscowles, Blackburn; Harold B. Holthouse, 42, St. Ann's Valley, Nottingham; Alexander Sinclair Hughson, 12, Myrtle Crescent, South Shields; Bertram Hunt, F.I.C., 5, Queen's Crescent, Glasgow; Richard Savory Ladell, 155, Praed Street, Hyde Park, London; William Fred Mawer, 16, Fentiman Road, S.W.; J. R. Morgan, Leydenburgh, Port Hall Street, Brighton; Frederick Morton, 101, Quarmby Road, Huddersfield; George F. Payne, M.D., Atlanta, Georgia, U.S.A.; Thomas Beilby Rawlins, 2, Levan Street, Pollockshields, Glasgow; George Percival Rees, Ely House, Basford, Stoke-on-Trent; Thomas Anderson Reid, Lostock Gralam, Northwich; Herbert Santer, Albion Brewery, Caledonian Road, N.; Philip Schidrowitz, 102, Oxford Gardens, Notting Hill, W.; W. Edgar Sims, B.Sc., Stafford House, Longsight, Manchester; Frederick Shapley, Whittier, Fuller & Co., San Francisco; Frederick Spencer, Rose Villa, Uttoxeter, Staffs; Robert Curling Styles, Knockhall, Greenhithe, Kent; Jocelyn Field Thorpe, Gloucester House, 20, Larkhall Rise, Clapham; William Herbert Walden, 55, Clapham Road, S.W.; Frank Ernest Welchman, 16, Carlton Road, Putney Hill, S.W.; William Gilchrist White, Lamb Roe, Whalley, Lancashire; Edward Humphreys Winder, 37, Vincent Square, S.W.; Stanley Wyndham, Ph.D., Judson, Florida, c/o Trenton Phosphor Co.

Of the following papers those marked * were read:—

*65. "The action of bromine on azobenzene—a correction." By Henry E. Armstrong.

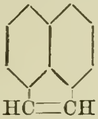
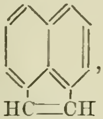
It was pointed out by me in a recent note in these Proceedings (1892, p. 194) that a compound represented by a formula such as is assigned to azobenzene, $Ph{\cdot}N{:}N{\cdot}Ph$, did not come within my "colour rule"; at the same time I drew attention to Werigo's *colourless* tetrabromazobenzene, and stated that Mr. Mills, at my request, had undertaken to further study the bromo-derivatives of azobenzene, and had already confirmed Werigo's observation.

According to Werigo, tetrabromazobenzene melts at 320°; the product obtained by Mr. Mills charred at a high temperature without melting; when boiled with tin and muriatic acid, it gave a tetrabromobenzidine, which was readily purified by crystallisation from boiling xylene; this melted at 285° (uncorr.), and proved to be identical with that prepared from benzidine, following the directions of Claus and Risler. This benzidine derivative was converted into a tetrabromodiphenyl melting at 189° (uncorr.), from which a small quantity of dimetabromobenzoic acid was obtained by oxidation.

During the course of the experiments, Mr. Mills was gradually led to notice that the original product from azobenzene was very similar to tetrabromobenzidine, and he eventually satisfied himself by repeatedly crystallising it from xylene that it was, in fact, nothing but impure tetrabromobenzidine. The difference in composition between tetrabromazobenzene and tetrabromobenzidine is so small that it is practically impossible to decide by analysis which compound is under examination; and the fact that tetrabromobenzidine is destitute of basic properties renders its differentiation difficult. Werigo's tetrabromazobenzene must therefore be struck off the list of known compounds; and no argument as to the constitution of azobenzene can be based on its behaviour with bromine.

*66. "The origin of colour. X. Coloured hydrocarbons." By Henry E. Armstrong.

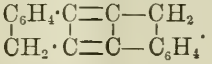
Graebe, in a recent note (*Ber.*, 1893, 2354), adduces what appears to be satisfactory evidence that the acenaphthylene, $C_{12}H_8$, discovered by Behr and Van Dorp, is actually a *yellow* hydrocarbon, and contends that the colour of this hydrocarbon and also that of the red hydrocarbon from fluorene (*cf.* these Proceedings, 1892, 192) is to be regarded as, in the first instance, conditioned by the presence of the group $>C{:}C<$. He ascribes the non-appearance of colour in ethylene derivatives generally to a secondary influence exercised by the groups displacing the hydrogen atoms in ethylene.

The problem is of such importance that I will venture to point out that in the case of coloured substances generally, the type of the series is itself always coloured—the only exception which I can call to mind being iodoform (*cf.* these Proceedings, 1893, 62). Acenaphthylene, no doubt, cannot well be represented otherwise than by the formula , but if possessed of an *ethenoid* structure akin to that of anthracene, an "explanation" of its colour may be given similar to that which I have put forward in the case of anthracene and of certain coloured quinoline derivatives (these Proceedings, 1893, 63). On inspecting the formula , it will be seen that the carbon atoms of the one nucleus are attached to the benzene nucleus on the left in ortho-positions and by ethenoid linkages; in other words, the hydrocarbon is an orthoquinonoid derivative. The external coupling is, in a measure, comparable with that which occurs in compounds such as methylene blue, &c., and it is this circumstance, perhaps, which causes the colour of the hydrocarbon to be so much more intense than that of anthracene, for example.

*67. "The formation of the hydrocarbon 'truxene' from phenylpropionic acid and from hydrindone." By F. Stanley Kipping, Ph.D., D.Sc

The further study of the hydrocarbon obtained from phenylpropionic acid (Proc., **112**, 107, **117**, 216) has led to the following results:—

The hydrocarbon is formed when hydrindone is heated either with phosphoric anhydride or with moderately concentrated sulphuric acid; it is also produced when a condensation product of hydrindone of the composition $C_{18}H_{14}O$ is heated with either of these dehydrating agents.

This condensation product will be described in a future paper; the fact that it is readily converted into the hydrocarbon proves that the latter has the formula $C_{18}H_{12}$, and not $C_{27}H_{18}$, and is also evidence in favour of the view that the constitution of the hydrocarbon is expressed by the formula 

$$\begin{array}{llll} C_6H_4\cdot & C= & C- & CH_2 \\ \vert & \vert & \vert & \vert \\ CH_2\cdot & C= & C- & C_6H_4 \end{array}.$$

This view affords a simple explanation of the formation of the hydrocarbon from phenylpropionic acid and of its relation to other compounds.

The hydrocarbon in question is evidently identical with a compound obtained by Hausmann (*Ber.*, **22**, 2019) by heating hydrindone with concentrated chlorhydric acid, the study of which he did not continue. It is also identical with "truxene," a hydrocarbon prepared by Liebermann and Bergami (*Ber.*, **22**, 782) by reducing "truxone" with iodhydric acid; this is proved by the fact that both compounds are converted into Gabriel and Michael's "tribenzoylenebenzene" (*Ber.*, **10**, 1557) on oxidation with chromic acid.

The author discusses the constitution of "truxene" and of "truxone," and points out that the formulæ assigned to them by Liebermann and Bergami (*Ber.*, **23**, 317) do not accord with the facts of the case, and are not to be reconciled with the formation of truxone from α-truxillic acid, $C_{18}H_{16}O_4$. It is also shown that the only evidence which led Liebermann and Bergami to assume that "truxene" is a "tribenzylenebenzene," namely, its conversion into "tribenzoylenebenzene" is of little, if of any, value.

The constitution of "tribenzoylenebenzene," being based on its conversion into triphenylbenzene, cannot be regarded as established, as it is first fused with potash at a high temperature and the product of this treatment is distilled over lime, in order to bring about the change. It follows, therefore, that the conversion of the hydrocarbon from phenylpropionic acid into "tribenzoylenebenzene" does not show that the former (truxene) has the molecular formula $C_{27}H_{18}$, but that "tribenzoylenebenzene," which was hitherto supposed to have the molecular formula $C_{27}H_{12}O_3$, is, in reality, $C_{18}H_8O_2$; this view is not refuted, but is rather corroborated by a study of the methods of forming "tribenzoylenebenzene."

The behaviour of truxene with nitric acid and with bromine and its oxidation to nitrophthalic acid [$2COOH : NO_2 = 1 : 2 : 4$] are described; attention is also drawn to a characteristic coloration which the hydrocarbon gives with ordinary concentrated sulphuric acid, and to its very peculiar decomposition by boiling nitrobenzene.

68. "The action of aluminium chloride on heptylic chloride." By F. Stanley Kipping, Ph.D., D.Sc.

The fact that hydrindone is formed in large quantities on treating phenylpropionic chloride with aluminium chloride (Proc., **117**, 216) led the author to investigate the action of the latter on heptylic chloride, as it appeared possible that methylketohexamethylene, ethylketopentamethylene or some other closed-chain compound might be formed.

After many unsuccessful experiments in which almost the whole of the heptylic chloride was recovered as heptylic acid, it was found that under suitable conditions a large proportion of the acid chloride was converted into a neutral oil which was isolated by distillation in steam, but which proved to be a mixture; on cooling the fractions of highest boiling point collected between 290° and 310°, a considerable quantity of colourless crystals was deposited which, when freed from oil, melted at about 41°. Analyses of this crystalline product gave results (I, C = 82·2, H = 10·2; II, C = 82·0, H = 10·0 per cent.) corresponding to the formula $C_{14}H_{20}O = 2C_6H_{13}{\cdot}COCl - 2HCl - H_2O - H_2$. It yields an oily hydroxime. On analysing this (found C = 75·4, H = 10·0, N = 6·7; required C = 76·7, H = 9·6, N = 6·4), the percentage of carbon found was somewhat lower than corresponds to the formula $C_{14}H_{20}NOH$, doubtless owing to the fact that the oil could not be purified.

It would seem, therefore, that the crystalline substance is a *ketone*, as was, in fact, to be expected.

The experiments which have been carried out up to the present with the object of determining its constitution, although few in number, have already afforded results of considerable interest. Fractions of the crude oil collected between 280° and 310°, when oxidised with nitric acid, gave a mixture of several acids, one of which was characterised by sparing solubility and was, therefore, easily isolated; analyses of this *acid* gave results pointing to the formula $C_{13}H_{10}O_6$ (found C = 59·4, H = 3·9; required C = 59·5, H = 3·8), and an analysis of its *silver salt*, $C_{13}H_7O_6Ag_3$ (found Ag = 55·1; required 55·5 per cent.) confirmed this view. Whether this acid is an oxidation product of the ketone $C_{14}H_{20}O$, or whether it is produced from some other constituent of the oil has not yet been determined, but in any case its indirect formation from heptylic acid is certainly rather extraordinary, as, to judge from its composition, it is a closed-chain compound.

The investigation of the behaviour of acid chlorides with aluminium chloride is being extended, and some progress has already been made with experiments with the chlorides of butyric, benzoylpropionic and hippuric acids.

*69. "The inertness of quicklime. II. The interaction of chlorine and lime." By V. H. Veley.

The author has ascertained by synthetical and analytical methods that no appreciable action takes place between dry chlorine and quicklime below 300°; above this temperature, a partial displacement of oxygen is effected by the chlorine: the interaction is thus analogous to that of baryta and chlorine, not specially dried, and at ordinary temperatures.

*70. "Note on hyponitrites." By D. H. Jackson, M.A., B.Sc.

The author has conducted experiments for the purpose of obtaining alkali hyponitrites, hitherto known only in solution, in a solid state. He confirms the experience of previous observers that, contrary to the statement of Menke, hyponitrite is not formed when sodium nitrate is heated with metallic iron. Reduction of a solution of sodium nitrate with aluminium or with barium amalgam does not furnish hyponitrite. For the production of hyponitrites, the author employs Divers' method of reducing a solution of sodium nitrate with sodium amalgam. He finds that the best yield of hyponitrite results from the use of an amalgam weak in sodium acting at a low temperature; owing to the violence of the action, no hyponitrite is obtained when sodium alone is used as the reducing agent. The origin of the metallic silver which generally contaminates silver hyponitrite produced by the usual process is traced to the reduction of silver hyponitrite by the hydroxylamine acetate contained in the solution in which precipitation is effected. In order to avoid loss of hyponitrite from this cause, it is recommended to add mercuric oxide to the alkaline solution resulting from the reduction. This destroys the hydroxylamine, and therefore the silver hyponitrite subsequently produced does not darken in the liquid. Although an aqueous solution of sodium hyponitrite quickly decomposes into sodium hydroxide and nitrous oxide, it was found that in the presence of much sodium hydroxide considerably less decomposition takes place. A strongly alkaline solution of sodium hyponitrite, prepared by reducing a strong solution of sodium nitrate, when spontaneously evaporated over sulphuric acid in a vacuum during several weeks, deposited crystals of sodium hyponitrite, which could be freed from hydroxide by washing with alcohol, in which the hyponitrite is very sparingly soluble. The crystals may also be obtained by precipitating a strong aqueous solution of the salt prepared by the interaction of silver hyponitrite and sodium chloride with alcohol. A determination of the sodium in these crystals showed that they possessed the composition of sodium hyponitrite.

Ammonium hyponitrite was obtained in groups of long needles by decomposing silver hyponitrite with an alcoholic solution of ammonium sulphide and evaporating the filtered liquid over sulphuric acid in a vacuum. Like the sodium salt, this compound is difficult to obtain in any quantity, and this circumstance prevented the author from further investigating the properties of these hyponitrites.

71. "The interaction of hydrogen chloride and potassium chlorate."

By W. H. Pendlebury, M.A., and Mrs. McKillop.

The authors have determined the amount of oxidising gases (whether chlorine or its oxides) removed on passing a given volume of air at a given rate through an aqueous solution of potassium chlorate and hydrogen chloride kept at a constant temperature, and have compared the amount removed with that present in the liquid. The evolved gases were received in a solution of potassium iodide, and at the end of each half hour the amount of iodine liberated was determined.

The following results were obtained at 30° with a mixture containing 30 grams of potassium chlorate and 18·823 grams of hydrogen chloride in 800 c.c.; the half-hourly determination of iodine was not performed during 41½ hours, 5·5 hours after mixing.

Hours after mixing.	Mass of iodine liberated.	Hours after mixing.	Mass of iodine liberated.
2·0	0·0021	47·5	0·0028
2·5	0·0032	48·0	0·0025
3·0	0·0038	48·5	0·0022
3·5	0·0035	68·0	0·0012
4·0	0·0034	69·0	0·0015
4·5	0·0028	69·5	0·0016
5·0	0·0025	70·0	0·0015
5·5	0·0022	71·5	0·0016
47·0	0·0023	72·0	0·0015

In a second set of observations, twice the amount of hydrogen chloride was used ($KClO_3$: 4HCl).

Hours after mixing.	Mass of iodine liberated.		Hours after mixing.	Mass of iodine liberated.	
0·5	0·012		35·0	0·042	
1·0	0·017		40·0	0·048	
1·5	0·018		44·5	0·045	
2·0	0·022	0·026	45·0	0·040	
2·5	0·026		45·5	0·040	
3·0	0·022		50·0	0·039	
3·5	0·024		53·5	0·030	0·31
4·0	0·028		54·0	0·033	
4·5	0·026		65·0	0·030	
5·0	0·029		65·5	0·032	
5·5	0·024		66·0	0·030	
6·0	0·029		66·5	0·031	
6·5	0·028		70·0	0·032	
24	0·042		90·0	0·033	

100 c.c. portions were withdrawn at regular intervals from a solution of the same strength as that used in the second set of experiments kept at 30°, and the amount of iodine liberated thereby was ascertained.

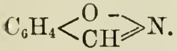
Hours after mixing.	Iodine liberated.	Hours after mixing.	Iodine liberated.
1	0·0021	24	0·0031
2	0·0022	28	0·0036
3	0·0024	29	0·0036
4	0·0022	31	0·0041
5	0·0023	32	0·0041
6	0·0024	46	0·0055
7	0·0029	47	0·0054
8	0·0033	76	0·0045
22	0·0032	77	0·0045
23	0·0031	94	0·0047

A comparison of the two sets of observations shows that only a portion of the oxidising gases is removed by the passage of the air.

Observations are referred to showing that a solution such as was used in these experiments—which after exposure during 46 hours in subdued light—liberated iodine to the extent of 0·0055 gram per 10 c.c. after exposure at a window to bright sunlight during 30 minutes liberated only 0·0038 gram per 10 c.c.; after one hour's exposure the amount liberated had fallen to 0·0023, but no further reduction took place after 3½ hours' exposure. On removal into subdued light, the iodine-liberating power increased, being 0·0035 after four hours, and rising to 0·0048 after 20 hours in the dark. As solutions of the oxides of chlorine lose in oxidising power on exposure to light, the change observed in the chlorate solution is probably due to their destruction.

72. "The formation of indoxazen derivatives." By Wm. A. Bone, Ph.D.

The author has investigated the behaviour of orthochloronitrobenzaldoxime towards alkalis with a view to isolating nitrindoxazen,



$C_6H_4\left<\begin{matrix}O\ -\\ CH\end{matrix}\right>N.$

Orthochlorobenzal chloride was converted by the action of fuming sulphuric acid into the corresponding aldehyde, which was then nitrated, and the nitrated aldehyde was converted into the hydroxime; on subjecting this to the action of caustic potash at 130°, ammonia was evolved, and hydrogen chloride was split off. On acidifying the solution, a white precipitate was thrown down, which, after recrystallisation, melted at 222°; it possessed acid properties, and gave a red colour with ferric chloride solution. Analysis of the silver salt showed it to be 1 : 2 : 5-nitrosalicylic acid.

The hydroxime was then heated at 120° with a solution of sodium carbonate; hydrogen chloride was split off, but no ammonia was evolved. On acidifying the liquid, beautiful yellow needles appeared, melting at 189°.

The properties of the product (especially the facts that it gave a red colour with ferric chloride, and on heating with caustic potash yielded 1 : 2 : 5-nitrosalicylic) pointed to the conclusion that it was 1 : 2 : 5-nitrosalicylonitril, isomeric with nitrindoxazen, a molecular change having occurred during the interaction. In order to decide the question, the hitherto unknown nitriles of 1 : 2 : 5-nitrosalicylic acid were investigated. Several attempts were unsuccessfully made to prepare these by well-known interactions; at last, by heating salicylaldoxime with acetic anhydride, and subsequently hydrolysing with dilute caustic potash, an almost quantitative yield of salicylonitril was obtained.

On nitrating salicylonitrile with fuming nitric acid, the 1 : 2 : 3 : 5-dinitronitril was obtained crystallised in yellow plates, melting at 175°; unlike other members of the salicylic series, it gave no coloration with ferric chloride.

On using ordinary nitric acid, and conducting the nitration below 0°, the 1 : 2 : 5-mononitronitril was obtained. This crystallises in long, pale yellow needles melting at 190°; it gave a red coloration with ferric chloride, and was found to be identical with the product obtained from orthochloronitrobenzaldoxime and sodium carbonate.

Derivatives of these nitriles were prepared and studied, notably their amidoximes. That of the mononitronitril is a weak base; its hydrochloride crystallises in yellow tablets melting at 215°. That of the dinitronitril is a neutral substance, crystallising in orange tablets melting at 204°.

The author, finally, attempted to prepare nitromethylindoxazen. Indoxazen itself is evidently exceedingly unstable, but it was thought that a methyl derivative would be more stable, and it seemed likely that orthochloronitracetophenonoxime would yield nitromethylindoxazen.

The hitherto unknown orthochloracetophenone was prepared by the action of orthochlorobenzoyl chloride on ethylic acetosodacetate, and subsequently hydrolysing the product. All attempts to prepare orthochloronitracetophenone from this failed, however, owing to the fact that nitration was accompanied by simultaneous oxidation.

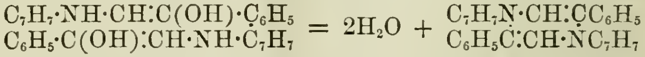
Orthochloracetophenone is a colourless oil which boils at 235—240°.

Orthochloronitracetophenone was prepared by the action of orthochloronitrobenzoyl chloride on ethylic acetosodacetate, and subsequently hydrolysing the product. It is a very thick syrup, becoming crystalline on standing. The author was unsuccessful in preparing the hydroxime from this, although experiments were made under various conditions (at ordinary temperature, at 100°, and under pressure at 130°); in all cases the ketone was unaltered, owing, probably, to the very negative character of the $C_6H_3(NO_2)Cl$ group.

73. "The interaction of benzylamine and phenacyl bromide. Synthesis of piazine derivatives." By Arthur T. Mason, Ph.D., and Goodlatte Winder, Ph.D.

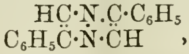
Phenacyl bromide and benzylamine easily interact, forming monophenacylbenzylamine, $Ph{\cdot}CO{\cdot}CH_2{\cdot}NH{\cdot}CH_2{\cdot}Ph$, and diphenacylbenzylamine, $(Ph{\cdot}CO{\cdot}CH_2)_2N{\cdot}CH_2{\cdot}Ph$.

These compounds were isolated in the form of hydrobromides, as on setting the bases free, molecular changes take place; in the case of monophenacylbenzoylamine, 2 molecules combine to form 1:4-dibenzyl-2:5-diphenylpiazine dihydride, the condensation being analogous to that which takes place in the case of isoamidoacetophenone:



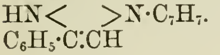
$$\begin{array}{l} C_7H_7{\cdot}NH{\cdot}CH{:}C(OH){\cdot}C_6H_5 \\ C_6H_5{\cdot}C(OH){:}CH{\cdot}NH{\cdot}C_7H_7 \end{array} = 2H_2O + \begin{array}{l} C_7H_7N{\cdot}CH{:}CC_6H_5 \\ C_6H_5C{:}CH{\cdot}NC_7H_7 \end{array}.$$

On heating the dihydride to the boiling point toluene is eliminated and 2:5-diphenylpiazine,



$$\begin{array}{l} HC{\cdot}N.C{\cdot}C_6H_5 \\ C_6H_5C{\cdot}N{\cdot}CH \end{array},$$

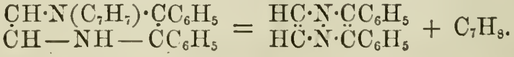
is formed, the product being identical with that from isoamidoacetophenone (*Ber.*, **21**, 1269). When diphenacylbenzylamine is set free it is probably converted into an oxazine derivative. Cold alcoholic ammonia converts the hydrobromide of diphenacylbenzylamine quantitatively into an amide, $(C_6H_5{\cdot}C(OH){:}CH)_2N{\cdot}C_7H_7$, which, at 100°, loses one molecule of water, 2:6-diphenyl-4-benzylpiazine dihydride being formed,



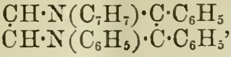
$$HN\!\!<\!\!\begin{array}{l} C_6H_5{\cdot}C{:}CH \\ \\ C_6H_5{\cdot}C{:}CH \end{array}\!\!>\!\!N{\cdot}C_7H_7.$$

The same condensation occurs on warming the amide with dilute chlorhydric acid, the hydrochloride of the dihydride being formed.

When further heated, the hydride, as well as its hydrochloride, yields 2:6-diphenylpiazine, toluene or benzyl chloride, as the case may be, being eliminated.



$$\begin{array}{l} CH{\cdot}N(C_7H_7){\cdot}CC_6H_5 \\ CH-NH-CC_6H_5 \end{array} = \begin{array}{l} HC{\cdot}N{\cdot}CC_6H_5 \\ HC{\cdot}N{\cdot}CC_6H_5 \end{array} + C_7H_8.$$

Aniline and benzylamine act on diphenacylbenzylamine hydrobromide forming the dihydride,  $\begin{array}{l}CH{\cdot}N(C_7H_7){\cdot}C{\cdot}C_6H_5 \\ CH{\cdot}N(C_6H_5){\cdot}C{\cdot}C_6H_5\end{array}$, and 1 : 4-dibenzyl-2 : 6-diphenylpiazine dihydride.

On heating the latter compound with concentrated chlorhydric acid at 170°, two atoms of hydrogen are eliminated ; the product is devoid of basic properties and unaltered by benzoyl chloride and acetic anhydride, and is probably 2 : 6-diphenyl-3 : 5-dibenzylpiazine. If, however, 1 : 4-dibenzyl-2 : 6-diphenylpiazine dihydride be heated alone at 260—270°, toluene is eliminated, and the remaining benzyl radicle probably " wanders " from nitrogen to carbon, 2 : 6-diphenyl-3-benzylpiazine being found.

These transformations are comparable with those occurring when toluidine and xylidine are formed by heating the hydrochlorides of monomethyl- and dimethyl-aniline.

On treating the dihydride with an alcoholic solution of ferric chloride and chlorhydric acid, it yields 2 : 6-diphenyl-4-benzylpiazine dihydride.

74. "The interaction of quinones and metanitraniline and nitroparatoluidine : a preliminary note." By James Leicester, Ph.D.

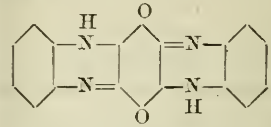
The relationship between quinonedianilide and azophenine has been pointed out by O. Fischer and E. Hepp (*Ber.*, 1888, 683) who also prepared fluorindine from the latter compound (*Ber.*, 1890, 2789).

In a previous paper (*Ber.*, 1890, 2793 ; this Journal, Abstracts, 1890, 1445) I gave the results of an investigation of the action of orthonitraniline and metanitroparatoluidine on quinone, toluquinone and naphthaquinone and showed that in principle the interaction was the same as in the case of aniline and quinone ; for example, orthonitraniline and quinone combine to form quinonediorthonitranilide, $C_6H_2O_2(NHC_6H_4NO_2)_2$ [CO : NH = 1 : 2 : 4 : 5], which on reduction with ammonium sulphide yields quinonehomofluorindine.

In addition to the quinonefluorindines certain quinonephenazine derivatives were obtained ; these are formed from the nitro-compounds corresponding to quinoneanilide, quinoneorthonitrotoluide yielding quinoneorthomethylphenazine. I have now prepared a number of other quinonephenazines and quinonefluorindines ; in fact the interaction appears to be a general one in the case of paraquinones. The constitution of these compounds may be inferred partly from the manner in which they are formed and partly from their similarity in properties to the corresponding fluorindines. A number of crystalline compounds have also been obtained by the reduction of the anilides and toluides with magnesium: the products are, however, of a somewhat complex nature and their further investigation is proceeding.

Quinonedimetanitranilide is prepared by heating a solution of quinone and metanitraniline in glacial acetic acid; it crystallises from a mixture of methyl alcohol and benzene, and melts at 295°.

Quinonemetanitranilide is obtained together with the dianilide as a bronze-coloured powder melting at 135°.

Quinonemetahomofluorindine, , is formed by the reduction of the dianilide with ammonium sulphide; it is a brownish-black powder melting above 360°. It affords a brown colour with acetic acid, changing to slaty green, and finally to mauve, on the gradual addition of sulphuric acid.

Quinoneparanitrotoluide is obtained in a similar manner as a bluish-black, crystalline powder; on reduction with ammonium sulphide it yields a slate-coloured compound which decomposes at about 300°.

Quinonediparanitrotoluide is a bronze-coloured substance; on reduction it yields a substance which melts at 320°, and dissolves in alcohol, benzene or acetic acid forming a dark, greenish-yellow coloured liquid, exhibiting a green fluorescence.

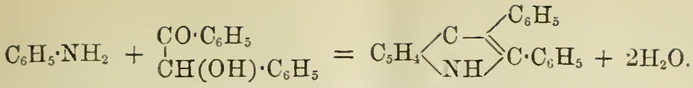
Thymoquindiorthonitranilide, from thymoquinone and orthonitraniline, crystallises from alcohol and ether in straw-coloured needles melting at 125°. The phenazine, $\overset{1:4}{C_6}O_2(\overset{6}{C_3}H_7)(\overset{3}{Me})<\genfrac{}{}{0pt}{}{\overset{2:5}{N}}{N}>C_6H_4$, derived from it, forms grey needles melting at about 320°.

Thimoquindiparanitrotoluide is deposited from absolute alcohol in yellowish-red plates melting at 112°; it also crystallises in needles.

Thymoquinorthomethylphenazine, $C_6O_2(C_3H_7)(Me)<\genfrac{}{}{0pt}{}{N}{N}>C_6H_3Me$, is a greyish white crystalline powder which sublimes at 325°, and dissolves in acetic acid and ether, forming a yellow-coloured liquid.

75. "Preparation of α-β-diphenylindoles from benzoïn and primary benzenoid amines." By R. Japp, F.R.S., and T. S. Murray, D.Sc.

The authors have found that a mixture of benzoin, aniline and zinc chloride yields E. Fischer's α-β-diphenylindole according to the equation



$$C_6H_5\cdot NH_2 + \begin{matrix}CO\cdot C_6H_5\\ | \\ CH(OH)\cdot C_6H_5\end{matrix} = C_5H_4\left\langle\begin{matrix}C - C(C_6H_5)\\ NH\end{matrix}\right\rangle C\cdot C_6H_5 + 2H_2O.$$

By employing in place of aniline, orthotoluidine, paratoluidine, α-naphthylamine and β-naphthylamine, they obtained respectively α-β-diphenylorthotoluindole (m. p. 136°), α-β-diphenylparatoluindole (m. p. 153°), α-β-diphenyl-α-naphthindole (m. p. 141°) and α-β-diphenyl-β-naphthindole (m. p. 166°).

Their work had proceeded thus far when a paper appeared by Bischler and Fireman (*Ber.*, **26**, 1336), in which the preparation of these indoles (with the exception of α-β-diphenyl-α-naphthindole) by a different method was described. This method consisted in first acting on cold desyl bromide with a primary benzenoid amine so as to obtain a desylanilide, thus, $C_6H_5\cdot CO\cdot CH(NHC_6H_5)\cdot C_6H_5$, and then boiling this compound with an excess of amine, when, according to Bischler and Fireman, it is converted into an indole.

The authors now show :—

1. That the desylanilides described as new by Bischler and Fireman are, in reality, identical with the anilbenzoin series obtained by Voigt (*J. pr. Chem.* [2], **34**, 2) by heating benzoin with aniline, paratoluidine and β-naphthylamine respectively. The constitution assigned to the compounds by Bischler and Fireman, which differs from that given by Voigt, is, however, correct.

2. That these desylanilides, contrary to the statement of Bischler and Fireman, are not converted into indoles by boiling them with amines. In order that this transformation may occur, it is necessary that the hydrochloride or hydrobromide of the amine should also be present. The desylanilides used by these authors were, from the mode of preparation, doubtless contaminated with aniline hydrobromide.

3. That the foregoing indoles, with the exception of α-β-diphenyl-β-naphthindole can be most readily obtained by boiling benzoin with a mixture of a primary benzenoid amine and its hydrochloride. α-β-Diphenyl-β-naphthindole is best prepared by the zinc chloride method.

The authors also find that all these indoles when crystallised from acetone form definite compounds with 1 mol. of acetone ("acetone of crystallisation"). In the case of α-β-diphenyl-α-naphthindole, similar compounds with ethyl methyl ketone and diethyl ketone were prepared.

ADDITIONS TO THE LIBRARY.

I. *Donations.*

The Nature of Things: a Didactic Poem translated from the Latin of Titus Lucretius Carus, by J. M. Good. (With Latin text.) 2 Vols. 4to. London 1805. From Hy. Bassett, Esq.

The Chemistry of Wine, by G. J. Mulder; edited by H. Bence Jones. London 1857. From W. Whitaker, Esq.

On Sewage Treatment and Disposal, by T. Wardle. Manchester and London 1893. From the Author.

Practical Pocket-Book of Photography, by E. Vogel: translated, from 2nd German edition, by E. C. Conrad. London 1893. From the Translator.

Smithsonian Miscellaneous Collections. Vol. XXXVI. A Select Bibliography of Chemistry, 1492—1892, by H. C. Bolton. Washington 1892. From the Institution.

Rudiments of Chemistry, by Temple Orme. Second edition. Washington 1893. From the Author.

Imperial Institute Series. Handbooks of Commercial Products. Indian Section:—

No. 2. Ipecacuanha, Calcutta 1892.
No. 3. Podophyllum emodi. Calcutta 1892.
No. 7. Resin and Turpentine from Indian Pines. Calcutta 1893.
No. 8. Iron: Southern Districts, Madras Presidency. Calcutta 1892.
No. 9. Indian Coal. Calcutta 1893.
No. 10. Adhatoda vasica. Calcutta 1892.
No. 11. Linseed. Calcutta 1893.
No. 13. Cutch. Calcutta 1893.
No. 14. Kut (The Costus). Calcutta 1893.
No. 15. Turpeth, or Indian Jalap. Calcutta 1893.
No. 16. Kamala Dye. Calcutta 1893.
No. 18. Jalap. Calcutta 1893.
No. 20. Castor Oil. Calcutta 1893.

From the Imperial Institute.

A Manual of Mineralogy, by R. Allan. Edinburgh 1834.

A Translation of the Pharmacopœia of the Royal College of Physicians of London, 1836, by R. Phillips. Fourth edition. London 1841.

The London Dispensatory, by A. T. Thomson. London 1815.

Chemical Experiments, by G. Francis. Third edition. London 1845.

A System of Chemistry. 4to. Philadelphia 1791.

An Introduction to Practical Chemistry, by J. E. Bowman. 4th edition, edited by C. L. Bloxam. London 1861.

Instructions for the use of the Blow-Pipe and Chemical Tests, with additions and observations derived from the recent publications of Professor Berzelius, by J. Mawe. Fourth edition. London 1825.

From — Hart, Esq.

Experimente mit Strömen hoher Wechselzahl und Frequenz, zusammengestellt von E. de Fodor, revidirt und mit Anmerkungen verschen von N. Tesla. Wien, Pest, Leipzig 1893.

From the Publishers.

II. *By Purchase.*

Handbuch der anorganischen Chemie, herausgegeben von O. Dammer. Band III. Stuttgart 1893.

Zusammensetzung und Verdaulichkeit der Futtermittel; nach verhandenen Analysen und Untersuchungen, zusammengestellt von T. Dietrich und J. König. Zweite Auflage. 2 Bande. Berlin 1891.

Kurzes Lehrbuch der organischen Chemie, von A. Bernthsen. Vierte Auflage, bearbeitet unter Mitwirkung vor E. Buchner. Braunschweig 1893.

Hand- und Hilfsbuch zur Ausführung Physikochemischer Messungen, von W. Ostwald. Leipzig 1893.

The Metallurgy of Lead and the Desilverization of Base Bullion by H. O. Hofman. Second edition. New York 1893.

RESEARCH FUND.

A meeting of the Research Fund Committee will be held in December. Fellows desiring grants are requested to make application before December 9th.

At the next meeting on November 16th, the following papers will be read:—

"The normal butylic, heptylic and octylic salts of active glyceric acid." By Professor Percy Frankland, F.R.S., and John MacGregor, M.A.

"The ethereal salts of diacetylglyceric acid in their relation to optical activity." By Professor Percy Frankland, F.R.S., and John MacGregor, M.A.

"The oxidation of paratoluidine." By A. G. Green.

"The products of the action of benzoyl chloride on urine in the presence of alkali." By Dr. J. W. L. Thudichum.

CERTIFICATES OF CANDIDATES FOR ELECTION AT THE NEXT BALLOT.

N.B.—The names of those who sign from "General Knowledge" are printed in *italics.*

The following Candidates will be balloted for on 7th December, 1893:—

Bowman, Frederic Edmund,

Ash Leigh, Bowdon, Cheshire.

Analytical Chemist. Was educated at Rugby, and afterwards studied under Professor Smithells, at the Yorkshire College, Leeds. Has passed his intermediate examination for B.Sc. in Chemistry. At present has charge of one of the laboratories at Messrs. Bowman, Thompson, and Co., Ld., Northwich.

Fredc. H. Bowman.
Thomas Wardle.
H. Grimshaw.
George H. Hurst.
J. Carter Bell.
John Knowles.
Watson Smith.
Arthur H. Tuer.
Percy Carter Bell.

Briggs, Harry Fielden,

Roseneath, Torquay.

Doctor of Dental Surgery; D.D.S. University College, Mich.; L.D.S. Faculty of Physicians and Surgeons, Glasgow; D.Sc. and B.Sc. Univ. Ohio. First Class Queen's Prizeman in Theoretical and Practical Chemistry.

Edward Smith.
George Cheverton.
Walter H. Coffin.
Jno. Wiltshire.
Arthur Turner.
R. L. Taylor.

Browne, Frank,

Government Civil Hospital, Hong Kong.

Assistant Apothecary and Assistant Analyst in the Government Civil Hospital, Hong Kong. Studied Chemistry and Practical Chemistry during one year in the School of Pharmacy of the Pharmaceutical Society; was a Medallist in Chemistry. Subsequently worked one year in the Research Laboratory of the Pharmaceutical Society. For the last $3\frac{1}{2}$ years have been Assistant Demonstrator of Practical Chemistry in the laboratories of the Pharmaceutical Society.

Wyndham R. Dunstan. John Attfield.
M. Carteighe. Thos. S. Dymond.
Chas. M. Luxmoore.

Brunton, John Dixon,

Wire Mill, Musselburgh.

Metallurgical Student. First Class Honours in Metallurgy, Assoc. S.T.S. after three years' course at the Sheffield Technical School, including Analytical Chemistry, Mathematics, Physics, and Metallurgy.

J. O. Arnold. Fredk. J. Merrils.
B. W. Winder. *G. T. W. Newsholme.*
Jno. C. Platts.

Caines, Charles March,

11, Clockhouse Road, Beckenham, Kent.

Analytical Chemist. First Class Honours Certificate in Chemistry, South Kensington Science and Art Department. Four years' experience in Analytical Chemistry under Mr. Alfred H. Allen.

Alfred H. Allen. A. Wynter Blyth. Otto Hehner.
C. G. Moor. J. Kear Colwell. B. E. R. Newlands.
John A. R. Newlands.

Carswell, Thomas Petson,

369, Scotswood Road, Newcastle-on-Tyne.

Analyst and Teacher at Newcastle Chemical and Pharmaceutical Tutorial. Pharmaceutical Chemist and Memb. Pharm. Soc. Author of Papers "On the Volumetric Estimation of Phenols by Iodine," Pharmaceutical Conference, 1892; "On a New Class of Iodine Phenol Derivatives," *Chem. News* (to appear immediately in series); "On Animal Charcoal," *Pharm. J.*, 28th January, 1893. Analyst to Borough Analyst of Bradford during summer vacancies, 1892 and 1893.

Alex Crum Brown. F. M. Rimmington.
F. W. Richardson. *Thos. Maben.*
W. A. H. Naylor.

Chaney, Harry J.,

29, Chalcot Crescent, Regent's Park, London.

Metallurgist. Associate of the Royal School of Mines. Studied Chemistry under Professor E. Frankland, F.R.S., and Metallurgy under Professor Roberts-Austen, F.R.S., Chemist to the Mint.

Work carried on includes :—1. Chemistry of the various methods and products of Carbonization. 2. The Chemistry and economic application of the various lixiviation processes, more especially the Russell and allied processes. 3. The nature of the Gold Quartz deposits of the Rolad Gold Fields, India, and experimental work of all kinds in connection with Paw and Stamps Amalgamation (1889—1893). All private work.

E. Frankland. W. R. Eaton Hodgkinson.
G. Matthey. David Watson.
W. C. Roberts-Austen. Percy F. Frankland.

Cocking, Allan Thomas,

39, Lister Street, Rotherham.

General Manager of Kynoch's Explosives and Ammunition Works. Three years Chemist and Works Manager, Flameless Explosives Works. Four years Chemist and Manager, Chemical Works at Aldworke Colliery for treating products from coke ovens. Eight years Teacher of Chemistry, Rotherham School of Science and Art. Three years Lecturer on Chemistry, Rotherham College.

W. Carleton Williams. L. T. O'Shea. George Young.
J. O. Arnold. Ralph E. Brown.

Craw, John A.,

2, Millgate, Cupar-Fife.

Science Master, Bell-Baxter Institute, Cupar-Fife; also Lecturer on Chemistry, Cupar Burgh School of Science, Glasgow and West of Scotland Technical College. Student 1886—1891. Analytical Chemist and Assayer at Parkhead Steel Works for two years. Assistant Science Master, Harris Academy, Dundee. South Kensington Certificates in Honours, Chemistry; City and Guilds of London in Honours, Iron and Steel Manufacture.

A. Humboldt Sexton. Geo. Ritchie. Thos. A. Cheetham.
Horatio Ballantyne. *James Robson.*

Ellis, Charles Sordes,

17, Bloomsbury Square, W.C.

Assistant Demonstrator of Chemistry at the Pharmaceutical Society. Late Student in the Laboratories of Owens College, Manchester, and University College, Aberystwith, Assistant to J. H. Lester, M.Sc., Consulting Chemist, Manchester.

Harold B. Dixon. G. H. Bailey.
H. Lloyd Snape. W. H. Perkin, jun.
Gilbert J. Fowler. John Attfield.
Harry Grimshaw. *Howard C. Sacré.*

Forrester, Alexander M.

22, Scotia Street, Glasgow.

Technical Chemist. For over four years assistant to Mr. J. Falconer King, City Analyst of Edinburgh; studied under Professor W. H. Perkin, jun., at Heriot-Watt College, Edinburgh; at present Head Chemist with Messrs. Alex Cross and Sons, Port Dundas Chemical Works, Glasgow.

J. Falconer King.
W. H. Perkin, jun.
James Stenhouse.
John Hunter.
F. Stanley Kipping.
W. S. Curphey.

Garnett, Henry,

2, Bartholomew Villas, Kentish Town, N.W.

Chemist and Analyst to the Vinolia Soap Works, Kentish Town, London. Studied Chemistry and Practical Chemistry as Bell Scholar, at the School of the Pharmaceutical Society, 1890—1891. Passed the Major Examination of the Society, 1891. Silver Medallist in Chemistry and in Practical Chemistry. Pereira Medallist, 1891. Afterwards worked in the Research Laboratory of the Pharmaceutical Society, 1891—92, and during a part of 1893.

Wyndham R. Dunstan.
Thomas S. Dymond.
Gilbert J. Fowler.
John Attfield.
M. Carteighe.
Thos. P. Blunt.

Grieve, William Hotten,

226, Friern Road, East Dulwich, S.E.

Science Demonstrator, London School Board, and Science Lecturer, Surrey County Council. Author of three works upon Mechanics. Nine years Science Demonstrator, L.S.B. Four years Lecturer upon Natural Philosophy, St. Edward's College, Liverpool. Six years First Mathematical Master, Wesley College, Sheffield.

J. H. Gladstone.
Isaac S. Scarf.
Geo. Chaloner.
J. Howard.
Harry R. Redman.
H. Macan.
William J. Butcher.

Hadley, Harry Edwin,

The School of Science, Kidderminster.

Head-Master of Science School. Assistant Demonstrator of Physics in the Royal College of Science for one year. Demonstrator and Assistant Lecturer in Physics in the Owens College for three years. B.Sc. (Lond.) 1892. Associate of Royal College of Science.

Harold B. Dixon.
Arthur Harden.
Gilbert J. Fowler.
P. J. Hartog.
Arthur W. Crossley.
Gibson Dyson.

Hale, Henry Ormsby,

Oundle School, Northamptonshire.

Bachelor of Arts of Trinity College, Cambridge. Natural Sciences Tripos, Part I, 1889. Chemistry Master, Oundle School.

T. H. Easterfield. Sidney Skinner. W. J. Sell.
J. T. Hewett. S. Ruhemann.

Harris, Harold,

Denmark House, Tuffley Avenue, Gloucester.

Metallurgical Chemist. Student at Mason College during three Sessions; passed the Senior Examinations in Theoretical and Practical Metallurgy. Studied the Analysis of Explosives at Nobel's Explosives Co., Glasgow. Have acted as Engineer to Gold Mine on the Gold Coast, and as Metallurgical Chemist at Gold and Copper Mines in Bengal. Also analysed Nobel's Explosives in India. Joint Author, with Mr. Turner, of Paper on "The Native Manufacture of Iron in India" (Iron and Steel Institute, September, 1893). Author of Paper in course of publication, on "The Copper Mines of Singhborn, Bengal."

Thomas Turner. William A. Tilden.
W. W. J. Nicol. Sidney Williamson.
George Embrey. *J. M. Collett.*

Hesketh, Wm., B.A.,

School House, Ferriscowles, Blackburn.

Science Teacher. Lecturer in Chemistry to Lancashire C.C. B.A. Royal University of Ireland. Lecturer in Agricultural Chemistry to Norfolk County Council, 1881. Student in the Chemical Laboratories, Owens College, 1892, 1893.

Harold B. Dixon. G. H. Bailey.
Arthur Harden. W. H. Perkin, jun.
Gilbert J. Fowler.

Holthouse, Harold B.,

42, St. Ann's Valley, Nottingham.

Senior Assistant in the Pharmaceutical Laboratory of Boot's Pure Drug Company, Nottingham. Have been engaged in the Manufacture of Pharmaceutical Preparations and Chemicals for the last 15 years, during five of which studied under John S. Linford, F.I.C. Also studied Theoretical and Practical Chemistry four years at the University College, Nottingham, and have been working at Analytical Chemistry generally, but more especially as applied to the examination, testing, and standardising of Drugs, Chemicals, and Galenicals.

Frank Clowes. J. Bernard Coleman.
R. Lloyd Whiteley. *Frank T. Addyman.*
Edgar B. Truman.

Hughson, Alexander Sinclair,

12, Myrtle Crescent, South Shields.

Chemist. I have been a student of Chemistry and Physics seven years, and have passed the examinations of the Pharmaceutical Society of Great Britain, and of the South Kensington Science and Art Classes.

A. B. Griffiths. Harold Follows. Alexander Hay.
Thomas A. Pooley. *E. C. Conrad.*

Hunt, Bertram, F.I.C.,

5, Queen's Crescent, Glasgow.

Analytical Chemist. (1) "Researches on Chemical Equivalence. II. Nickelous and Cadmic Sulphates," by E. J. Mills, D.Sc., F.R.S. and Bertram Hunt. (2) "Estimation of Tannin," and "Note on the Destruction of Tannin by Boiling Solutions of Gambier," by Bertram Hunt (*J. Soc. Chem. Ind.*, **4**, 263).

Edmund J. Mills. Richd. Reynolds.
Fredk. Woodward Brown. Arthur Smithells.
J. Lewkowitsch. Wm. McD. Mackey.

Ladell, Richard Savory,

155, Praed Street, Hyde Park, London, W.

Chemist. I have been a student of Chemistry and Physics for the past 13 years, and have passed the examinations of the Pharmaceutical Society and Apothecaries' Hall.

A. B. Griffiths. H. Follows.
Alexander Hay. Lionel Cooper.
Alfred H. Allen. *Thomas A. Pooley.*
C. T. Kingzett. *E. Wightman Bell.*

Mawer, William Fred,

16, Fentiman Road, S.W.

Chemical Demonstrator. Is an undergraduate of London University. Studied Chemistry for three years and passed the Minor and Major Examinations of the Pharmaceutical Society. Subsequently gave up the practice of Pharmacy, and has been for the last three years Assistant in the South London Public Laboratory.

John Watts. W. Henry Dodd.
L. de Koningh. *S. F. Burford.*
Lewis Ough. *George T. Holloway.*
J. West Knights.

Morgan, J. R.,

Leydenburgh, Port Hall Street, Brighton.

Science Master at the Grammar School, Brighton. Three years Student at University College, Aberystwyth, under the late Professor J. S. Humpidge. Three years Student at University College, Cardiff, under Professor Thompson and Dr. Turpin. Passed 1st B.Sc., London University with Honours, and Final B.Sc. with 2nd Class (3rd place) Honours in Chemistry. Have now taken Chemistry up as a Profession.

R. E. Hughes. G. S. Turpin. Claude M. Thompson.
E. P. Perman. J. Tudor Cundall.

Morton, Frederick,

101, Quarmby Road, Huddersfield.

Manufacturing Chemist and Tar Distiller. Studied Chemistry at Huddersfield Technical School and Bradford Technical College under Mr. C. Rawson, and Yorkshire College, Leeds, under Professor Smithells. Honours, Practical Chemistry, 1892. Had experience in Chemical and Tar Works of J. and E. Morton, Milnsbridge, Huddersfield, and am still in that position as Head Chemist and Tar Distiller.

Arthur Smithells. Herbert Ingle. J. B. Cohen.
C. Rawson. H. Ellison.

Payne, George F., M.D. Ph., G.,

Atlanta, Georgia, U.S.A.

Analyst, and as stated below. State Chemist of Georgia. Analyst of Agricultural Department. Member of Georgia Board of Pharmacy. Pharmaceutical Examiner. Professor of Materia Medica and Toxicology, Atlanta College of Pharmacy. Special Chemical training in Columbia College School of Mines, New York City, U.S.A., 1873 and 1874. Graduated New York College of Pharmacy. Graduated Atlanta Medical College. Life Member Georgia Pharmaceutical Association. Life Member Georgia State Agricultural Society. Member of the "Association of Official Agricultural Chemists" of the United States.

Elwyn Waller. Hermann T. Vulté.
C. F. Chandler. Arthur H. Elliott.
Albert B. Prescott.

Rawlins, Thomas Beilby,

2, Leven Street, Pollokshields, Glasgow.

Chemist and Colour Manufacturer. 1st Class Honours Science and Art Exams. 1883 or 1884. Teacher (Chemistry) Leeds Mechanics Institute 1883 and 1884. Chemist and Manager of Colour Works.

Investigations on the Protection from Corrosion of Iron and Steel Structures.

Edward Rawlins.	Herbert Eccles.
John Wm. Biggart.	*E. G. McBretney.*
Edward M. Chaplin.	*Arthur W. Cooke.*

Rees, George Percival,

Ely House, Basford, Stoke-on-Trent.

Assistant Blast Furnace Manager and Analytical Chemist. Six years' experience as Metallurgical Chemist. Science and Art Department's Certificates in Honours (1st), Inorganic (Practical), and in Advanced Organic (Theoretical and Practical), and Organic Honours, 1st Class (Practical).

H. E. Brothers.	Harry Silvester.
Herbert Pilkington.	J. E. Stead.

Sydney J. Harris.

Reid, Thomas Anderson,

Lostock Gralam, Northwich.

Manager of Chemical Works. 15 years' experience in Theoretical, Practical, and Manufacturing Chemistry. Special experience in the Manufacture of Pulp from Wood. Prize Essayist on this subject at International Forestry Exhibition, Edinburgh, 1884. Engaged during last 8 years in the development and working of the Ammonia Soda Process. At present entire charge of Chemical Department of Bowman, Thompson, and Co.'s, Limited, ammonia soda factory.

Fredc. H. Bowman.	John Knowles.
Francis Henry Tate.	J. Carter Bell.
H. Grimshaw.	*George H. Hurst.*
Arthur H. Tuer.	*Percy Carter Bell.*

Santer, Herbert,

Albion Brewery, Caledonian Road, N.

Brewer. I have studied Chemistry for some time in the laboratory of Messrs. Gillman and Spencer, and am still continuing. I am also engaged in my own laboratory at brewery, and take a great interest in Chemistry as applied to Brewing.

Alex. W. Gillman.	Sam. Spencer.
F. Jewson.	*J. Farrow Ballard.*

W. H. Blake.

Schidrowitz, Philip,

102, Oxford Gardens, Notting Hill, W.

Research Chemist (from October, 1893) to Queensferry Tar Works, Chester. Certificate of Technical Chemical School, Zürich (Federal

Polytechnic); here studied under Professors Lunge, Hantzsch, &c.) Degree of Ph.D. University of Bern. Published Dissertation "Beiträge zur Kenntniss der Xanthongruppe," Bern, 1893, K. Wys about "*o*-Dixanthon" (*Journal of German Chemical Society*, **93**, i, 75); at Bern studied under v. Kostanecki, &c.

W. F. Lowe, Temple Orme. John Bairstow.
William Ramsay. *Hy. Forster Morley.*

Sims, W. Edgar, B.Sc. (Vict.),

Stafford House, Longsight, Manchester.

Late Student of the Owens College—no occupation at present. For three years Student in the Chemical Laboratories, Owens College. B.Sc. (1st class Honours in Chemistry) Victoria University. Mercer Scholar; Le Blanc Medallist; Dalton Prizeman. Joint Author of paper on "Thionyl Bromide" (*Proc. Chem. Soc.*).

G. H. Bailey. Arthur W. Crossley.
Francis Jones. W. H. Perkin, jun.
Harold B. Dixon. Arthur Harden.
Gilbert J. Fowler. P. J. Hartog.

Shapley, Frederick,

Whittier, Fuller & Co., San Francisco.

Paint and Colour Chemist. Learnt business under W. Urquhart, London, W. Afterwards Chemist and Superintendent to the English Enamel Paint Company, New York. Then Chemist and Superintendent of Binswanger and Pollock's Colour Factory, Philadelphia, Pa. Then Chemist and Superintendent of the Wieder Paint Company's Factory, St. Louis. And at present with Whittier, Fuller and Company, San Francisco; and also doing original work in A. A. Cunningham's Laboratory, San Francisco.

A. Auchie Cunningham. Arthur F. Price.
Thos. W. Salter. *Stevenson Macadam.*
W. Ivison Macadam. *Thomas A. Pooley.*
A. B. Griffiths.

Spencer, Frederic,

Rose Villa, Uttoxeter, Staffs.

Chemist. I have passed the Examinations of the Pharmaceutical Society of Great Britain, &c.

Lionel Cooper. A. B. Griffiths.
Harold Follows. *James D. Johnstone.*
E. C. Conrad.

Styles, Robert Curling,

Knockhall, Greenhithe, Kent.

At present engaged installing Professor Roberts-Austen's Recording

Pyrometer in Ironworks. I have acted as Assistant to the late Dr. A. J. Bernays, at St. Thomas's Hospital, correcting proofs of his last book. Studied three years at the Royal College of Science, and have obtained the Associateship in Metallurgy. Student of Inst. Chem.

W. C. Roberts-Austen. T. K. Rose.
Henry C. Jenkins. F. W. Bayly.
Edwin J. Ball.

Thorpe, Jocelyn Field,

Gloucester House, 20, Larkhall Rise, Clapham.

Chemist. Has passed through the Chemistry and Physics courses at the Royal College of Science. Has also studied Chemistry and Physics at King's College, London.

T. E. Thorpe. W. Palmer Wynne.
John M. Thomson. G. Stillingfleet Johnson.
Herbert Jackson. Wm. Tate.

Walden, William Herbert,

55, Clapham Road, S.W.

Chemical Expert in H.M. War Department. For 3 years engaged in Chemical Research and Practical Analysis in the Laboratory of John Woodland, Esq., F.C.S., F.L.S., &c., and still engaged in original research.

A. B. Griffiths. E. C. Conrad. Lionel Cooper.
Harold Follows. *E. Wightman Bell.* *Richard Weaver.*
Thomas A. Pooley. *William Crookes.* *Chas. A. MacMunn.*
Alfred H. Allen.

Welchman, Frank Ernest,

16, Carlton Road, Putney Hill, S.W.

Assistant to Dr. Hake, Westminster Hospital Medical School, Caxton Street, S.W. Educated at Queenwood College, Hants (1881–86). Matriculated, London University, June, 1889. Student of the Institute of Chemistry. Pupil during 4 years in the laboratory of Dr. Hake, Westminster Hospital Medical School. At present assisting Dr. Hake.

A. Dupré. H. Wilson Hake. Wm. Macnab.
H. Sprengel. *Charles E. Groves.*

White, William Gilchrist,

Lamb Roe, Whalley, Lancashire.

Print Works Chemist at Whalley Abbey Print Works (Messrs. Bryce, Smith, & Co.). I have been for the past 3 years Practical Chemist at the above Works, with 4 years' previous training in Chemistry and the allied sciences (2 years) at the Glasgow Technical

College, and the following 2 years with the late Professor Dittmar, where I obtained 1st Class Certificates in the subjects I studied. I have studied Practical Photography and its Chemistry for several years, and have done a little Research on the subject as a Student (see *Andersonian Chem. Journal*, November, 1889, and March, 1890), which I am at present engaged following up.

Alfred M. Hanson.
Thomas Gray.
M. W. Jones.
G. G. Henderson.
James G. Hardy.
A. Humboldt Sexton.
James Robson.
Alexander Lauder.
Fred Marsden.

Winder, Edward Humphreys,

37, Vincent Square, London, S.W.

Science Master, Westminster School. B.A. (Oxon.): former Exhibitioner in Natural Science at New College, Oxford: and worked for 4 years in the University Laboratories (Chemical).

John Watts.
V. H. Veley.
W. W. Fisher.
H. Brereton Baker.
Wm. Odling.

Wyndham, Stanley, Ph.D.,

Judson, Florida, c/o Trenton Phosphor Co.

Analytical Chemist. Two years' course at Polytechnicum, Hanover. Five years' course at University of Freiburg, Baden; graduated (Ph.D) in 1887; subject of original research: Thesis "Beiträge zur Kenntniss der Isophtalsäure." 1887–93 engaged as Analytical Chemist in America.

Boverton Redwood.
John A. R. Newlands.
Thomas Tyrer.
Bernard Dyer.
B. E. R. Newlands.

HARRISON AND SONS, PRINTERS IN ORDINARY TO HER MAJESTY, ST. MARTIN'S LANE.

Issued 25/11/1893.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

No. 129. Session 1893-94.

November 16th, 1893. Dr. Armstrong, President, in the Chair.

Messrs. J. H. Coste, R. C. T. Evans and C. A. Mitchell were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. David Anderson, 14, St. Julian's Road, Kilburn, N.W.; William Edward Bamber, Spring Lawn, Heaton, Bolton; William Rowland Bird, 73, Albion Street, New Swindon, Wilts; Chuni Lal Bose, 24, Mohendro Bose's Lane, Calcutta; John Cannell Cain, Stubbins Villa, Stubbins, near Manchester; F. D. Chattaway, St. Bartholomew's Hospital, E.C.; Samuel Henry Davies, Dalton Hall, Manchester; John Duncan, M.D., St. Petersburg, Russia; Frank Evershed, Kenley, Surrey; George Trench, Standard House, Faversham; Ernest William Gay, 14, St. Julian's Road, Kilburn, N.W.; Edward Frank Harrison, 17, Bloomsbury Square, W.C.; Edmond Herbert Hills, Darland House, Chatham; John Winder Holmes, 28, Crooms Hill, Greenwich; David Hamilton Jackson, M.A., B.Sc., Royal College of Science, South Kensington; George F. Gaubert, Ph.D., Anilin Fabrik, Ludwigshafen am Rh.; Robert Leonard Jenks, 68, Victoria Road, Clapham, S.W.; A. Lapworth, 13, Duchess Road, Birmingham; Godfrey Melland, Victoria Park, Manchester; J. M. Murray, B.Sc., Highfield, Holmes Chapel, Cheshire; Richard Paulusz, Colombo; William Henry Pearson, 5, Bryn Villas, Blaina, Monmouth; J. Holms Pollock, 37, Athole Gardens, Glasgow; Meredith Young, M.B., C.M., Brighouse, Yorks.

The following is the text of a letter addressed by the President to Professor Mendeléef, the President of the Russian Chemical Society, St. Petersburg:—

"Learning that the Society over which you preside will celebrate its 25th Anniversary on the 18th of this month, I beg, on behalf of the Chemical Society of London, to tender our most hearty congratulations and our good wishes for the future.

"Notwithstanding the grave difficulties which your language imposes, your English colleagues learn from time to time of your labours, the name of your Society and a record of its work regularly appearing in our volume of abstracts of chemical papers. We are thus frequently brought face to face with researches of the greatest interest and importance, and the wish that we could enjoy less restricted intercourse with our Russian colleagues is often felt among us. We look forward to the time when this wish will be gratified, and trust that it may not be far distant.

"Our Society is proud to have enrolled your name on its list of foreign members, and to have welcomed you as one of its Faraday Lecturers; and the roll also includes the name of Beilstein, which, however, is no longer the mere name of an individual, but a household word throughout the chemical world, and one which cannot be mentioned without the feeling of gratitude arising in the chemist's mind. There are many other names of Russian chemists indelibly associated in our memories with discoveries of fundamental importance."

Of the following papers those marked * were read :—

*76. "The normal butylic, heptylic and octylic ethereal salts of active glyceric acid." By Percy Frankland, Ph.D., B.Sc., F.R.S., and John MacGregor, M.A.

The authors have previously described the preparation and properties of the methylic, ethylic, propylic, isopropylic, normal, secondary and isobutylic salts of both inactive and active glyceric acids, and have shown that in ascending the homologous series of salts of active glyceric acid the rotatory power increases with the molecular weight, but that the rotation of the normal butylic compound is considerably less than this general relationship indicated it should be. In order to ascertain whether the increase in rotatory power continues indefinitely as the molecular weight increases, they have now prepared and examined the heptylic and octylic salts, and have also again prepared the normal butylic salt, which they had not before obtained in a state of purity. As will be seen from the subsequent table, the results show that the rotatory power does not increase indefinitely as the homologous series is ascended, but that a maximum rotation is reached apparently at the butylic compound in the case of the normal series, the specific rotation of the heptylic being less, and that of the octylic still less than that of the normal butyl compound.

Such a maximum rotation in a homologous series has been predicted by Guye from a consideration of the successive values of the product of asymmetry, but the calculated maximum, as will be seen from the table, falls on the propylic instead of on the butylic compound. In the case of the salts containing secondary radicles, of which, however, only the isopropylic and secondary butylic compounds have been examined, the maximum rotation is actually exhibited by the propylic compound as predicted by calculation.

Ethereal salt.	Density. 15°/15°.	Observed rotation in 198·4 mm. tube. $(\alpha)_D$.	Specific rotation. $[\alpha]_D$.	Mol. rotation. $[M]_D$.	Mol. deviation. $[\delta]_D$.	Product of asymmetry. $(P \times 10^6)$.
Methylic.......	1·2798	−12·2°	− 4·80°	− 5·76	−27·9	283·8
Ethylic........	1·1921	−21·7	− 9·18	−12·30	−52·8	344·8
Propylic.......	1·1448	−29·4	−12·94	−19·15	−74·9	358·2
Isopropylic.....	1·1303	−26·5	−11·82	−17·49	−67·8	358·2
Butylic (norm.).	1·1084	−29·0	−13·19	−21·37	−77·0	346·8
Isobutylic	1·1051	−31·2	−14·23	−23·05	−82·9	346·8
Butylic (sec.) ...	1·1052	−23·2	−10·58	−17·14	−61·7	346·8
Heptylic.......	1·0390	−23·3	−11·30	−23·05	−68·3	268·7
Octylic........	1·0263	−20·8	−10·22	−22·28	−62·6	241·8

*77. "The ethereal salts of diacetylglyceric acid in relation to the connection between optical activity and chemical constitution." By Percy Frankland, Ph.D., B.Sc., F.R.S., and John MacGregor, M.A.

The methylic, ethylic, propylic, isopropylic and isobutylic salts of active diacetylglyceric acid were prepared by heating the corresponding salts of active glyceric acid with an excess of acetyl chloride, and then fractionally distilling *in vacuo.* These compounds are colourless, almost inodorous liquids, volatilising without decomposition even under ordinary atmospheric pressure at between 200° and 300°. The special interest attaching to them consists in the circumstance that, both in the methylic and ethylic compounds respectively, two of the groups attached to the asymmetric carbon atom are of equal mass, and, therefore, according to Guye's theory, these two compounds should be inactive, or nearly so, or at any rate some of the members of this series should exhibit a rotation of opposite sign to that exhibited by the glycerates. As will be seen from the table, some of these anticipations are realised, the sign throughout being similar to that of the ethereal salts of glyceric acid, the increase in rotation on ascending the series of diacetylglycerates proceeding on lines almost parallel to those followed in ascending the glycerate series, the diacetylglycerates only starting from a higher level of rotation, so to speak. The authors consequently again urge the necessity of also taking into consideration the qualitative nature of the groups attached to the asymmetric carbon atom, and not their masses only.

Ethereal salt.	Density 15°/15°.	Observed rotation at 15° C. in 198·4 mm. tube $(\alpha)_{D}$.	Specific rotation $[\alpha]_{D}$.	Molecular rotation. $[M]_{D}$.	Molecular deviation. $[\delta]_{D}$.	Products of asymmetry $(P \times 10^{6})$.
Methylic	1·1998	−28°·65	−12°·04	−24°·56	− 80·0	0·0
Ethylic	1·1574	−37·46	−16·31	−35·56	−108·2	0·0
Propylic	1·1263	−43·52	−19·47	−45·17	−129·5	17·4
Isopropylic ...	1·1193	−39·90	−17·97	−41·69	−119·1	17·4
Isobutylic	1·0990	−44·66	−20·48	−50·38	−136·7	41·9

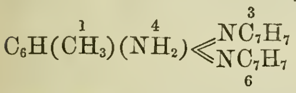
DISCUSSION.

Mr. L. M. JONES observed that inasmuch as the product of dissymmetry employed presupposes the equality of the distances of the centres of gravity of the combined groups from the central carbon atom, it can only give an approximate indication of where the maximum "molecular deviations" will be found. In the case of the diacetylglycerates, as the salts which have this product = 0 show marked activity, we should expect considerable divergence between the observed and predicted maxima.

Mr. RODGER drew special attention to the fact that the "molecular deviation," $\frac{\alpha}{l} \times \sqrt[3]{\frac{M}{d}}$, employed by Guye in a recent communication, was probably the true value of the molecular rotatory power. $\frac{\alpha}{l}$ is evidently the angle of rotation produced by unit length of substance. $\sqrt[3]{\frac{M}{d}}$ is the molecular length or a length which for different substances contains the same number of molecules, and the "molecular deviation" is, therefore, proportional to the angle of rotation produced by the same number of molecules or to the rotation per molecule. The dimensions of this quantity are those of an angle —the physical magnitude actually measured—whereas the ordinary measure of molecular rotation $\frac{\alpha}{l} \times \frac{M}{d}$ is an angle multiplied by a surface. He also pointed out that the effect of temperature on rotatory power had been little studied. Such experiments as had been made indicated, however, that the temperature change varied with the chemical nature of the substance, and hence that relationships obtained at the same temperature, according to the usual custom, would no longer be the same if the temperature of comparison were altered. For these reasons the significant speculations of Guye could only be subjected to a fair test when "molecular deviations" had been measured at temperatures at which, as regards the property under consideration, the substances were in comparable states.

*78. "The oxidation of paratoluidine." By Arthur G. Green.

The red crystalline substance obtained by Barsilowsky in 1873 by oxidising paratoluidine with potassium ferrocyanide has been variously considered as a polymeric parazotoluene, as a tritoluylenediamine and a complex amidoazo-compound. The author has re-examined this remarkable substance. He arrives at the conclusion that the substance is a diparatolylimide represented by the formula



$C_6H(\overset{1}{C}H_3)(\overset{4}{N}H_2)\Big\langle\begin{matrix}N\overset{3}{C}_7H_7\\ N\underset{6}{C}_7H_7\end{matrix}$ derived from amidotoluquinone. This conclusion is deduced from the following facts. The base has the empirical composition C_7H_7N, and its molecular weight corresponds to the formula $C_{21}H_{21}N_3$. By treatment with chlorhydric acid it is readily decomposed, one paratoluidine residue being split off and a second being removed by further treatment of the intermediate product. On reduction, it takes up 2 atoms of hydrogen, affording a stable, colourless leuco-base. This latter is readily reoxidised to the original substance, has very slight basic properties, and is not decomposed by acids or further reduced by boiling with stannous chloride. The leuco-base condenses readily with benzil forming a coloured azonium compound; and it yields colourless, non-oxidisable anhydro-compounds with formic and acetic acids, thus showing all the characteristics of a mono-substituted orthodiamine. This result, taken in conjunction with the presence of two paratolylimide groups in the original substance, as shown by its decomposition by acids, proves that the leuco-base is a diparatolyltriamidotoluene. Of the three possible formulæ for this compound the greatest probability attaches to that in which the two tolylamido-groups are relatively in the para-position. This formula would represent the leuco-base as an amido-derivative of diparatolylparatolylenediamine. The diparatolylparatolylenediamine was accordingly prepared by heating hydrotoluquinone with paratoluidine and zinc chloride and submitted to comparison with the leuco-base. A marked similarity in appearance and properties was observable, entirely in accordance with the view that the latter is the amido-derivative of the former. Moreover, the diparatolylparatolylenediamine was converted by oxidation into toluquinonediparatolyldiamine, and this substance showed a striking similarity in its appearance and in all its properties to Barsilowsky's base. There could, therefore, be little doubt that the tolylamido-groups in the leuco-base and the tolylimido-groups in the original compound occupy the para-position to each other, and that consequently the constitution of the Barsilowsky base is that given above, whilst its leuco-compound must be represented by the formula $C_6H_2(CH_3)(NH_2)(NHC_7H_7)$ [1 : 4 : 3 : 6]. In agreement with this conclusion, the synthesis of Barsilowsky's base was effected by oxidation of a mixture of orthamidometaparaditolylamine and paratoluidine in acetic acid solution, whilst its lower homologue was prepared in a similar manner from orthamidometaparaditolylamine and aniline.

*79. "The action of benzoic chloride on urine in presence of alkali. Formation of benzoic derivatives of urochrome." By J. L. W. Thudichum, M.D., F.R.C.P.

The author has examined the products of the action of benzoic chloride on urine in the presence of alkali. The urine rendered strongly alkaline with soda, and filtered from the precipitated phosphates, is mixed with benzoic chloride in the proportion of 50 c.c. for each litre of urine used. The mixture is kept cool and constantly agitated, care being taken to maintain a strong alkaline reaction. A yellowish-white, semi-solid precipitate separates, which by extraction with alcohol may be separated into three parts: (1) an oily substance soluble in cold alcohol, (2) a solid soluble in hot alcohol, (3) a small quantity of a solid insoluble in boiling alcohol, which was not further examined. The oil and the solid substances are considered to be mixtures of various benzoic derivatives of *urochrome*, the normal colouring matter of urine, and of alcoholic compounds present in the urine. The mixed solid derivatives of urochrome contain between 58·9 and 63·2 per cent. of carbon, 5 per cent. of hydrogen, and between 3 and 1·5 per cent. of nitrogen, from which the author concludes that they are mixtures of polybenzoic derivatives, as he found 12 per cent. of nitrogen in urochrome.

The solid benzoic derivatives may be most readily crystallised by dissolving the original precipitate in boiling absolute alcohol, filtering the hot liquid and evaporating until crystallisation begins. By fractionally crystallising the resulting mass from hot alcohol, the author separated it into three portions: (1) a crystalline solid not dissolved by boiling spirit ("insoluble ester"), (2) crystalline needles soluble in boiling spirit ("needle ester"). (3) laminæ resembling cholesterol in appearance soluble in cold spirit ("cholesteroid ester"). The mother liquor contains for the most part the oily benzoic derivatives of urochrome.

By the action of benzoic chloride on an aqueous solution of urochrome (prepared by the ferric chloride method), solid benzoic derivatives were obtained containing 1·77 per cent. of nitrogen. The same result may be secured by precipitating urine with phosphotungstic acid, regenerating by means of baryta and extracting the residue with alcohol. The alcoholic solution, when mixed with mercuric chloride, furnishes a precipitate containing the urochrome and other bases. If this precipitate be decomposed with hydrogen sulphide, an acid liquid is obtained which, when acted on with benzoic chloride and soda, affords a precipitate of the benzoic derivatives of urochrome. Similarly, if the precipitate obtained by adding phosphotungstic or phosphomolybdic acid to acidified urine be dissolved in soda and the solution be mixed with benzoic chloride, the same derivatives of urochrome are precipitated. From this behaviour the author concludes that urochrome is at once an alcohol and a base.

The benzoic derivatives of urochrome are hydrolysed by strong alkali, but the liberated urochrome is, to some extent, decomposed, especially if the liquid be heated. Some, however, may be recovered by acidulating the strong alkaline solution with dilute sulphuric acid and precipitating with phosphotungstic acid and decomposing the precipitate with barium carbonate in the usual manner. When the derivatives are hydrolysed by heating with dilute sulphuric acid, much of the liberated urochrome suffers decomposition, producing the substance called by the author *uropittin*, as well as other urochrome "resins" (*uromelanin* and *omicholin*). Neither urochrome nor its black decomposition product, uromelanin, are carbohydrates. Both contain nitrogen.

The "cholesteroid" benzoic derivative obtained from urine furnished on combustion results agreeing with the formula $C_{13}H_{12}O_{5}$. When hydrolysed with dilute sulphuric acid, it yields about 50 per cent. of benzoic acid, together with a resinous substance. It contained only a trace of nitrogen, and is probably the derivative of an alcohol. The author obtained no benzoic derivative of any substance in the nature of a sugar (*cf.* Wedenski, *Zeit. physiol. Chem.*, **13**, 122).

80. "The combination of hydrocarbons with picric acid and other nitro-compounds." By William A. Tilden and Martin O. Forster.

The authors have instituted a compound described by Lextrait in 1886, which is formed by heating picric acid with pinene. It contains the elements of picric acid and a terpene, but differs from the picrates of other hydrocarbons in forming a peculiar potassium salt, in yielding picramide and borneol when submitted to the action of alcoholic ammonia, and in forming borneol and not simply a hydrocarbon under the influence of aqueous alkalis.

The authors have also instituted experiments on the behaviour of other hydrocarbons with nitro-compounds generally, from which it appears that, in order that a compound may be formed, at least *two* nitro-groups must be present in the nitro-derivative concerned. They conclude that the oxygen of the nitro-groups affords the link which, in ordinary cases, binds the hydrocarbon to the nitro-compound, while in the case of the pinene derivative the oxygen of the hydroxyl is probably also involved.

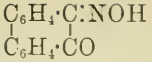
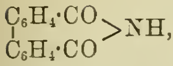
81. "The formation of pyrrol derivatives from aconitic acid." By S. Ruhemann, Ph.D., M.A., and F. E. Allhusen, B.A.

The authors find that when the ethereal salt of dibromotricarballylic acid (which they prepared by exposure of a mixture of ethylic aconitate and bromine to direct sunlight) and aniline interact, besides a compound melting at 87—88°, which they regard as ethylic anhydroanilaconitate, an oil is formed which, on heating at 250—260°, yields an isomeride, ethylic phenylpyrrolonedicarboxylate, melting at 181°.

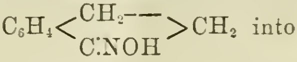
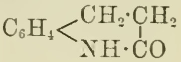
82. "The conversion of α-hydrindonoxime into hydrocarbostyril." By F. Stanley Kipping, Ph.D., D.Sc.

The peculiar intramolecular change first observed by Beckmann in the case of diphenylacetoxime has been carefully studied by V. Meyer, Hantzsch and others during the last few years, and it has been shown that a great many open-chain hydroximes may be converted into substituted amides in accordance with the equation RR′C:NOH = R·CO·NH·R′ or R·NH·CO·R′.

The behaviour of hydroximes of cycloid ketones, however, has been but little investigated. Camphoroxime has been shown to yield campholenonitrile, $C_{10}H_{15}N$, and not a substituted amide, as was to be expected from the behaviour of isonitrosocamphor, which yields camphorimide (Angelo, *Ber.*, **26**, 59; Manasse, *ibid.*, 241), and the only case, in fact, in which the desired change has hitherto been accomplished with the hydroxime of a cycloid ketone of known constitution appears to be that of phenanthraquinonemonoxime, which, as Wegerhoff has shown (*Ber.*, 1888,

2355), is readily transformed into diphenimide,  $\begin{array}{l}C_6H_4\cdot C{:}NOH\\ |\qquad\ \ |\\ C_6H_4\cdot CO\end{array}$ =  $\left.\begin{array}{l}C_6H_4\cdot CO\\ |\\ C_6H_4\cdot CO\end{array}\right>NH$, the closed chain of 6 carbon atoms being converted into a closed chain of 7 atoms by the introduction of an imido-group.

These considerations led the author to study the behaviour of hydrindonoxime. On subjecting this to the action of phosphorus pentachloride and water successively, it yielded a small quantity of a crystalline substance melting at 163°, represented by the formula C_9H_9NO (found C = 73·26; H = 6·32; required C = 73·47; H = 6·12 per cent.). As far as could be ascertained without direct comparison, this substance is identical with hydrocarbostyril.

This change from  $C_6H_4<\begin{array}{l}CH_2\text{---}\\ C{:}NOH\end{array}>CH_2$ into  $C_6H_4<\begin{array}{l}CH_2\cdot CH_2\\ NH\cdot CO\end{array}$ is, to some extent, analogous to the conversion of pyrroline into chloro- or bromo-pyridine, which appears to be one of the few cases on record of the conversion of a ring with 5 into one containing 6 elements, although the reverse operation, namely, the transformation of a ring containing 6 into one containing 5 elements is known, from Zincke's work, to be easily accomplished.

The publication of this note is desirable owing to the appearance of a paper by Wallach in the last number of the *Annalen* (**277**, 154), in which he describes preliminary experiments on the behaviour of hydroximes of cycloid ketones.

83. "The constitution of lapachol and its derivatives. II. The azines of the lapachol group." By Samuel C. Hooker.

The author gives an account of azines of the lapachol group prepared from orthotoluylenediamine, and fully discusses the relations existing between lapachol and α- and β-lapachone and the changes occurring in the quinone group in the course of the transformation of these compounds into each other. The constitution of several of the compounds is discussed in relation to their colour. The compounds described are methyllapazine, methylbromolapazine, methyllapeurhodone, methylhydroxylapeurhodone, methyl-α-naphtheurhodol and methylchloronaphtheurhodone.

ADDITIONS TO THE LIBRARY.

I. *Donations.*

Smithsonian Institution: Miscellaneous Collections. 850. A Select Bibliography of Chemistry, 1492—1892, by H. C. Bolton. Washington 1893. From the Institution.

Practical Agricultural Chemistry for Elementary Students, by J. B. Coleman and F. T. Addyman. London 1893.
From the Publishers.

Graham-Otto's Ausführliches Lehrbuch der Chemie. Dritte Auflage. Erster Band. Dritte Abtheilung. Beziehungen zwischen physikalischen Eigenschaften un Chemischer Zusammensetzung der Körper. Herausgegeben von H. Landolt. Erste Hälfte. Braunschweig 1893.
From the Editor.

Pamphlets.

The Origin of Melinite and Lyddite, by H. Sprengel. London.

A Contribution to the History of the Electric Incandescent Vacuum Lamp, by H. Sprengel. London 1891.
From the Author.

RESEARCH FUND.

A meeting of the Research Fund Committee will be held in December. Fellows desiring grants are requested to make application before December 9th.

At the next meeting, on December 7th, there will be a ballot for the election of Fellows, and the following papers will be read:—

"An apparatus for the extraction and estimation of the gases dissolved in water." By Dr. Truman.

"The oxides of the elements and the periodic law." By R. M. Deeley.

Correction in certificate of William Fred Mawer (Proc., No. 128, p. 226), *for* "John Watts" *read* "John Muter."

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Issued 16/12/1893.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

No. 130. Session 1893-94.

December 7th, 1893. Dr. Armstrong, President, in the Chair.

Messrs. E. A. Hancock and E. A. Warmington were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Henry Purefoy Fitz-Gerald, Wellington College, Berks; Alfred Hutchinson, The Leys, Cambridge; Frank Hughes, 27, Fairfield Road, Chelmsford; Norman Leonard, 2A, Lorn Road, Brixton, S.W.; Arthur Luty, 30, Bryn-y-Mor Terrace, Swansea; A. H. Macdonald, The Green, Marlborough, Wilts; David Paterson, Lea Bank, Roslin, N.B.; J. Cardwell, Quinn, Woodcroft, Gateacre, near Liverpool; Arthur Ross, 1, Glengall Road, Old Kent Road, S.E.; Walter Smithson Rowntree, 53, Grosvenor Road, London, S.W.; Richard A. Rouillard, 5, Dundonald Road Wimbledon, and Mauritius; Charles Henry Smith, Re Bungalow, Nassau, Bahamas, W.I.; Alfred E. Tanner, 2, Bruce Grove, Tottenham; Hamilton Marc Wingate, 3, Buckingham Street, Glasgow, W.

The following were duly elected Fellows of the Society:—Frederic Edmund Bowman; Harry Fielden Briggs; Frank Browne; John Dixon Brunton; C. M. Caines; Thomas Petson Carswell; Harry J. Chaney; Allan Thomas Cocking; John A. Craw; Charles Sordes Ellis; Alexander M. Forrester; Henry Garnett; W. H. Grieve; Harry Edwin Hadley; Henry Ormsby Hale; Harold Harris; Wm. Hesketh; H. B. Holthouse; Bertram Hunt; W. F. Mawer; J. R. Morgan; F. Morton; George F. Payne; G. P. Rees; Thomas Anderson Reid; Philip Schidrowitz; W. Edgar Sims; Frederick Shapley; Robert Curley Styles; Jocelyn Field Thorpe; William

Herbert Walden; Frank Ernest Welchman; William Gilchrist White; Edward Humphreys Winder; Stanley Wyndham.

Of the following papers those marked * were read:—

*84. "An apparatus for the extraction and estimation of the gases dissolved in water." By E. B. Truman, M.D.

The apparatus described is so constructed that the air having been removed chiefly by means of a water pump and ultimately by a Sprengel mercury pump, a measured bulk of the water can then be introduced, if desirable without allowing it to come into contact with the air. The dissolved gases which spontaneously escape from the water can be pumped off, and the water can be subsequently heated so as to drive off any gas remaining dissolved and also the carbon dioxide fixed by carbonates.

*85. "The magnetic rotation of hydrogen chloride in different solvents, and also of sodium chloride and of chlorine." By W. H. Perkin, Ph.D., F.R.S.

Experiments are described which have afforded results confirmatory of those previously published by the author. It is shown that when isoamylic oxide is nearly saturated with hydrogen chloride at temperatures between 0° and 25°, no appreciable interaction takes place, the values obtained by direct weighing agreeing with those afforded by titration with alkali; action takes place only very slowly between the two substances at ordinary temperatures. Hydrogen bromide acts far more rapidly on isoamylic oxide. It is further shown that hydrogen chloride acts extremely slowly on ethylic and isoamylic alcohols at ordinary temperatures. Hydrogen chloride when dissolved in these alcohols has a higher molecular rotation than when dissolved in isoamylic oxide, the value being, however, than that afforded by aqueous solutions, thus:—

In aqueous solution	4·300
In alcoholic solution................	3·324
In isoamylic oxide	2·245

The molecular magnetic rotation of sodium chloride was found to be 4·080 in the solid state, and 5·068 in aqueous solution.

The value obtained for chlorine, using a solution in carbon tetrachloride, was 2·188, which is considerably higher than the value calculated from compounds such as propyl chloride (1·733).

*86. "Analysis of water from the Zem-Zem well in Mecca." By C. A. Mitchell, B.A. (Oxon!), King's College, London.

Through the kindness of Lady Burton I have been enabled to make an analysis of water from the Zem-Zem well in Mecca, which was obtained from the well by the late Sir Richard Burton, disguised as a pilgrim dervish, in 1853.

The Zem-Zem well, according to tradition, is the well of Hagar, and is used for no other purpose than for drinking and religious ablution. Each pilgrim to Mecca is anxious to drink and bathe in the water, but as there is not sufficient for all the following device is adopted:—An Arab standing on the wall of the well draws the water up and pours it over the pilgrims as, stripped to the waist, they advance in turn. As it pours over him each drinks what he can, and the remainder runs down, soaking through the loin cloth, back into the well to be used again on succeeding pilgrims. If this practice has been continued day after day and year after year it is not surprising to find that the water is very rich in chlorine and albuminoid ammonia, and that the solid residue is large in amount.

The sample examined was contained in two small hermetically sealed tin bottles, which had remained untouched since Sir Richard Burton brought them from Mecca. Each held about 200 c.c. On opening them there was a slight evolution of gas. In each case there were minute silky crystals in suspension, and a few earthy particles settled at the bottom. These crystals, on examination, proved to be a tin compound, probably stannic hydrate, as they were unaltered on evaporating with strong nitric acid, and, after fusing them with pure sodium carbonate, no trace of chloride or sulphate could be detected in the solution. These foreign matters being filtered off, a clear and colourless filtrate was left, having a slight smell, more perceptible on warming, and distinctly alkaline to litmus paper. Neither tin nor lead was found in this solution. The relative density of the water at 14° was 1·0029. On analysis the following numbers were obtained :—

Grains per gallon.			Parts per million.		Hardness in terms of $MgCO_3$.
Nitrogen from nitrates and nitrites.	Total solids.	Chlorine.	Free and saline NH_3.	Albuminoid NH_3.	
4·496	219·5	69·3	71·4	2·2	23·3

The hardness in degrees of $CaCO_3$ = 43·05, but as the water was found to contain very little calcium and large quantities of magnesium, the hardness is given in terms of the latter, although probably it is mainly due to chlorides and sulphates.

The oxidised nitrogen present, determined by Lunge's nitrometer, was 4·496 grains per gallon = 19·91 grains NO_3.

On igniting the residue, white fumes from ammonium salts were given off, while the residue browned considerably and lost in weight an amount corresponding to 35·5 grains per gallon.

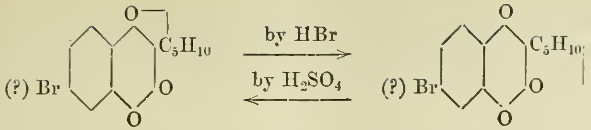
The following are the quantities of some of the constituents of the water actually determined, and calculated on 219·5 grains of total solids to the gallon.

SiO_2	3·0
Al	0·8
Ca	0·5
Mg	6·6
K	24·3
Na	38·3
NH_4	5·3
Cl	69·3
SO_4	30·7
NO_3	19·9

Professor Crookshank was kind enough to make an exhaustive bacteriological examination of some of the water, but was unable to discover any trace of living organisms. The water was sterile, as might well be expected, after its having been hermetically sealed and in total darkness during forty years.

87. "The preparation and properties of bromolapachol." By Samuel C. Hooker.

The author shows that although bromolapachol cannot be prepared by the direct action of bromine on lapachol; it is readily obtained by reducing dibromolapachone, the preparation of which he has previously described (Trans., 1893, 424). Bromolapachol crystallises in golden scales melting at 170—171°; it yields bromo-β-lapachone when dissolved in concentrated sulphuric acid. Bromo-β-lapachone closely resembles lapachone in its behaviour, being converted into bromo-α-lapachone by the action of bromhydric acid; the latter compound being reconverted into the former by dissolving it in concentrated sulphuric acid. Bromo-α-lapachone is a pale yellow substance melting at 178°; the isomeric *p*-compound is orange-red, and melts at about 205°.



Bromo-β-lapachone. Bromo-α-lapachone.

88. "Studies on citrazinic acid. Part II." By T. H. Easterfield and W. J. Sell.

The authors find that when diammonic citrate is heated during several hours at 130° in an open vessel, about 6 per cent. of citrazinic acid is produced. The ethylic salt of citrazinic acid yields the ammonium salt of citrazinamide when heated in a sealed tube with strong ammonia. Sodium amalgam reduces citrazinamide,

$$C_5H_4NO_2{\cdot}CONH_2,$$

to citrazinyl alcohol, $C_5H_4NO_2{\cdot}CH_2OH$, a small quantity of the corresponding hydrobenzoin being simultaneously produced; this behaviour is analogous to that of the amides of aromatic acids. The alcohol crystallises from water in monohydrated, colourless prisms, melting at 158°; its solution is very acid to litmus.

89. "The oxides of the elements and the periodic law." By R. M. Deeley.

The author discusses the properties of the oxides of the elements in connection with the modified periodic arrangement of the elements described in his previous communication (Trans., June, 1893).

In the diagram which accompanied that paper the "volume heats" and "volume atoms" of the elements were plotted as ordinates, the abscissæ being the atomic weights. Similarly a diagram has now been prepared, in which the ordinates are numbers obtained by dividing the relative densities of the oxides by the atomic weights of the corresponding elements. The results obtained are, in general, confirmatory of those deduced from the previous diagram, and lead to a somewhat similar periodic table, although the arrangement differs in several important respects from that proposed by Mendeléef.

90. "The freezing points of alloys in which the solvent is thallium." By C. T. Heycock and F. H. Neville.

The addition of lead to thallium raises the freezing point. The atomic falls caused by gold, silver, and platinum in thallium are closely accordant, the mean value being 6·31° as that due to 1 atomic proportion dissolving in 100 atomic proportions of thallium; with the aid of this value, the latent heat of fusion of 1 gram of thallium is calculated to be 5·12 calories. Bismuth exhibits the phenomena of a triple alloy, probably owing to the presence of impurity in the thallium.

ADDITIONS TO THE LIBRARY.

I. *Donations.*

Studies from the Physical and Chemical Laboratories of the Owens College. Edited by A. Schuster and H. B. Dixon. Vol. I. Physics and Physical Chemistry. Manchester 1893.
From the Editors.

Laboratory Teaching in Practical Chemistry. By C. L. Bloxam; edited by A. G. Bloxam. 6th Ed. London 1893.
From the Editor.

Physikalisch-chemische Tabellen, herausgegeben von H. Landolt und R. Börnstein. Zweite Auflage. Berlin 1893.
From the Editors.

Index to the Literature of Explosives. By C. E. Munroe. Part 2. Baltimore 1893. From the Compiler.

Smithsonian Miscellaneous Collections. 844. Meteorelogical Tables. Washington 1893. From the Institution.

Undersökningar öfver Svafvelurinämnens Förhällande till Oxidationsmedel, af D. S. Hector. Upsala 1892. From the Author.

Rules for the Estimation of Alcohol in Imported Spirits, by C. J. H. Warden. Calcutta 1892. From the Author.

Chemical Recreations: a popular compendium of Experimental Chemistry for the use of Beginners, by J. J. Griffin. 9th Ed. London 1849. From Dr. T. Stevenson.

Micro-organisms and Fermentation, by A. Jörgensen. Translated from the 3rd German edition by A. K. Miller and E. A. Lennholm. London 1893. From the Author.

II. *By Purchase.*

La Chimie au moyen âge, par M. Berthelot. Trois tomes. 4to. Paris 1893.

Lehrbuch der Mineralogie, von G. Tschermak. 4te Auflage. Wien 1893.

Die Untersuchung des Zuckers und zuckerhaltiger Stoffe, von E. Steydn. Wien, Pest und Leipzig 1893.

Arbeitsmethoden für Organisch-Chemische Laboratorien, von Lassar-Cohn. 2te Auflage. Hamburg und Leipzig 1893.

Specielle Methoden der Analyse; Anleitung zur Anwendung physikalischer Methoden in der Chemie, von G. Krüss. Hamburg und Leipzig 1893.

Physikalisch-chemische Methoden, von J. Traube. Hamburg und Leipzig 1893.

Physikalisches Praktikum; mit besonderer Berücksichtigung der physikalisch-chemischen Methoden, von E. Wiedemann und H. Ebert. Braunschweig 1893.

Die Phasenregel und ihre Anwendungen, von W. Meyerhoffer. Leipzig und Wien 1893.

Ueber die Entwickelung der Thierfarben-Industrie, von H. Caro. Berlin 1893.

Traité de Chimie Médicale et Pharmaceutique, par R. Huguet. Chimie Minérale. Paris 1893.

Tabellarische Uebersicht der Naphthalin-Derivate, von F. Reverdin und H. Fulda. Zwei Theile. 4to. Basel, Genf, Lyon, 1893.

Tabellen zum Gebrauche bei der Berechnung des Rohzucker-Rendements, von W. Bartz. Braunschweig 1893.

Grundriss der allgemeinen Thermo-chemie, von M. Planck. Breslau 1893.

At the next meeting, on December 21st, the following papers will be read:—

"The oxidation products of corydaline." By Professor Dobbie and Mr. Alexander Lauder.

"Note on the colouring matter of the Indian dye-stuff 'Tesu.'" By Professor Hummel and Dr. W. Cavallo.

"The interaction of acid chlorides and nitrates." By Dr. Armstrong and Mr. Lapworth.

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Issued 11/1/1894.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

No. 131. Session 1893-94.

December 21st, 1893. Dr. Armstrong, President, in the Chair.

Messrs. Frank Comyns, Martin O. Forster, Henry Garnett and Arthur R. Ling were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Walter Grafton, 11, Grosvenor Road, Upton Park, Essex; Robert Hamilton, 5, Lake Street, Hunslet, Leeds; W. Pellew Harvey, Golden, British Columbia; R. Hornby, B.A., Long Preston, Leeds; Walter Jardine, 86, Victoria Place, Perth; Clifford Walker Lee, the Atacama Mineral Company, Taltac, Chili; John Peven, Jun., Blair Terrace, Greenock; A. B. Robertson, Dungoyne, Bearsden, by Glasgow; William Lloyd Williams, Erbistock Villa, 10, Miskin Road, Dartford.

The following is the text of a reply received by the President to his recent letter of congratulation to the Russian Chemical Society; the letter is signed by D. Mendeleeff, President, and D. Konowalow, Secretary, of the Society:—

"In the name of Russian chemists we tender to you our hearty thanks for the congratulations and the sentiments expressed by you in your letter of the 15th November, 1893, in the name of the London Chemical Society.

"The possibility, suggested by you, of a closer tie between the eminent London Chemical Society and the young Russian one was received with greatest applause. We hope, as well as you, that the time is not far off when this closer connection will take place. We desire it the more as we expect to gain the more by it."

Of the following papers those marked * were read :—

*91. "Corydaline. Part III. Oxidation with potassium permanganate."
By James J. Dobbie, M.A., D.Sc., and Alexander Lauder.

By the oxidation of corydaline with potassium permanganate an acid is obtained which contains three atoms of carbon less than the alkaloid. This substance, which the authors have named corydalinic acid, has the formula $C_{19}H_{21}NO_{12}$. It is easily soluble in hot water, from which it separates, on cooling, in long, flat, prismatic crystals, containing 3 mols. of water of crystallisation. Corydalinic acid is also soluble in methyl and ethyl alcohol, but is insoluble in ether, chloroform and benzene.

When heated, corydalinic acid sublimes without changing, and then condenses in the form of beautiful, silky needles. It melts without decomposing between 175° and 180°.

Corydalinic acid is tetra-basic; the following salts have been prepared and analysed: a normal and acid silver salt, $C_{19}H_{17}NO_{12}Ag_4$ and $C_{19}H_{19}NO_{12}Ag_2$; an acid potassium salt, $C_{19}H_{19}NO_{12}K_2$; a normal and acid barium salt, $C_{19}H_{17}NO_{12}Ba_2$ and $C_{19}H_{19}NO_{12}Ba$; and the normal lead salt, $C_{19}H_{17}NO_{12}Pb_2$.

The acid silver salt, when carefully heated, yields a beautiful sublimate of corydalinic acid. The normal silver and barium salts are appreciably soluble in water; the lead salt is almost insoluble.

When treated with fuming iodhydric acid, one molecular proportion of corydalinic acid gives four molecular proportions of methyl iodide, showing that the four methoxy-groups which corydaline contains are still present in the acid. The formula of the acid may, therefore, be written $C_{11}H_5N(OCH_3)_4(COOH)_4$.

Corydalinic acid is split up into a number of simpler substances by the action of fuming iodhydric acid. Of these, the one which is formed in largest quantity is a non-nitrogenous acid, which crystallises from the iodhydric solution in long, slender, colourless needles. The formula of this acid, which the authors temporarily name corydalic acid, is $C_9H_{10}O_8$. When heated, corydalic acid melts at 200°, undergoing decomposition. It is a powerful reducing agent: when silver nitrate is added to its aqueous solution, a white precipitate is obtained, which partially dissolves on heating, and is partially reduced, silver separating; in presence of ammonia, the reduction is instantaneous, even in the cold. Copper acetate is rapidly reduced to cuprous oxide on heating with an aqueous solution of the acid. Ferric chloride colours solutions of the acid intense green, the colour changing to violet on the addition of ammonia or sodium carbonate. A phenol is evolved when corydalic acid is heated with lime.

The authors experienced great difficulty in obtaining definite salts of corydalic acid, partly on account of the ease with which some of them decompose, and partly because of the difficulty of ascertaining the precise conditions under which the acid and normal salts respectively can be obtained. A lead salt of the formula $C_9H_6O_8Pb_2$ was prepared, as well as a salt containing a larger proportion of lead.

Corydalic acid appears to be a dihydroxytricarboxylic derivative of a reduced benzene ring, the hydrogen both of the hydroxyl and carboxyl groups being displaceable by metal, as in the case of other phenolic acids.

The mother liquors from corydalic acid contain several substances, including a nitrogenous compound, which have not yet been investigated.

The authors consider it probable that corydalinic acid is a derivative of phenylpyridine, in which three carboxyl- and two methoxy-groups are united to a partially reduced benzene ring and one carboxyl- and two methoxy-groups to the pyridine ring. The formation of such an acid from corydaline would be most easily accounted for by the assumption that corydaline is itself a derivative of a naphthaquinoline. Corydalinic acid would thus be obtained from corydaline in the same manner as phenylpyridinedicarboxylic acids are obtained by the oxidation of the naphthaquinolines.

It is further probable that the three carbon atoms of corydaline which are split off during oxidation are attached to the benzene ring, and are represented by two of the three carboxyl groups present in this portion of the acid.

Corydaline is very stable towards potassium hydrate, only a small portion of the alkaloid undergoing alteration, even when heated at 180° during many hours with a large excess of this agent.

*92. "The properties of α-benzaldoxime and some of its derivatives." By Wyndham R. Dunstan, F.R.S., and C. M. Luxmoore, B.Sc.

The authors wish to place on record certain facts they have observed during the course of an investigation of the isomerism of the benzaldoximes which is not yet completed.

Crystallisation of α-Benzaldoxime.—More than a year ago they observed that α-benzaldoxime, which had been described by Petraczek, Beckmann, Hantzsch and previous observers as a yellowish oil, could be crystallised by cooling, with ice and salt, the colourless highly-refractive liquid obtained by distilling the yellow oil under reduced pressure. The substance is best recrystallised from its solution in light petroleum. The crystals melt at 34°. Both the isomeric benzaldoximes are, therefore, crystalline compounds, the β-oxime melting at 129°. As the result of a considerable experience in the preparation of the

α-compound the authors find the method suggested by Beckmann, in which the aldehyde is acted on by hydroxylamine, to be preferable to that proposed by Lachowitz (*Ber.*, **22**, 2887), namely, the interaction of hydrobenzamide and hydroxylamine hydrochloride.

Action of hydrogen chloride on α-Benzaldoxime.—Beckmann has shown that hydrogen chloride, as well as hydrogen sulphate, converts α-benzaldoxime into the isomeric β-benzaldoxime. The authors also find that, when the α-compound or its ethereal solution is charged with dry hydrogen chloride at the ordinary temperature, the hydrochloride of β-benzaldoxime is obtained, separating from the ethereal solution in pearly crystals which melt at 66—67°. This compound is best recrystallised from its solution in chloroform by the cautious addition of light petroleum. When dissolved in water at 0°, it dissociates into hydrogen chloride and β-benzaldoxime (which may be recovered by means of ether). If, however, the mixture be allowed to stand, especially at the ordinary temperature, the dilute acid quickly transforms the β-oxime into the α-oxime. Dry hydrogen chloride and aqueous hydrogen chloride, under the same conditions, tend, therefore, to induce isomeric change in opposite directions: the dry gas at ordinary temperatures changing the α-compound into the β-compound, whilst the aqueous acid, under similar circumstances, changes the β- into the α-compound.

Hantzsch did not succeed in producing a hydrochloride of α-benzaldoxime. The authors have obtained this substance by leading dry hydrogen chloride into an ethereal solution of the α-compound, well cooled below 0°, any rise in temperature being avoided. It is thrown down as a pulverulent precipitate melting somewhat indefinitely near 103°. When dry it appears to be perfectly stable at the ordinary temperature, but on attempting to crystallise it from chloroform isomeric change takes place, and the hydrochloride of the β-benzaldoxime is obtained. When acted on by dilute aqueous ammonia at 0°, the α-hydrochloride furnishes the α-oxime.

Action of hydrogen bromide and hydrogen iodide.—Neither the hydrobromide nor the hydriodide of α-benzaldoxime could be isolated. Even at temperatures below 0°, when these gaseous hydrides are led into an ethereal solution of the oxime, the hydrobromide and the hydriodide of β-benzaldoxime are produced. The *hydrobromide* ($C_6H_5CH{:}NOH$) melts at 77—78°; the *hydriodide* is unstable, decomposing on standing, iodine being liberated.

Action of hydrogen fluoride.—No hydrofluoride of α-benzaldoxime could be obtained. Hydrogen fluoride throws out from an ethereal solution of the oxime, cooled below 0°, a salt which proved, on analysis, to be the *dihydrofluoride* of β-benzaldoxime ($C_6H_5CH{:}NOH\cdot 2HF$).

Action of sulphuric acid.—Beckmann observed that when benzaldoxime is dissolved in concentrated sulphuric acid and the solution is poured into water at 0° the isomeric β-benzaldoxime results. The authors find that the isomeric change, as in the similar case of hydrogen chloride, is preceded by the formation of an unstable *α-benzaldoxime sulphate*, which may be prepared, as an oil, by mixing α-benzaldoxime with an ethereal solution of sulphuric acid cooled to about — 15°. Dilute aqueous ammonia acting at 0° regenerates α-benzaldoxime from this compound. The oily salt very readily undergoes isomeric change into solid β-benzaldoxime sulphate. On standing, or on vigorously stirring the liquid cooled to 0°, solidification occurs owing to the formation of *β-benzaldoxime sulphate* ($C_6H_5CH\!:\!NOH,H_2SO_4$), which furnishes β-benzaldoxime when decomposed at 0° with dilute aqueous ammonia.

Crystallisation of Acetyl-α-benzaldoxime.—This compound has hitherto been regarded as an oil. It can, however, when pure, be crystallised by vigorously stirring the liquid cooled below 0°. The crystals melt between 14° and 16°. Both the acetyl-α-benzaldoxime and the acetyl-β-benzaldoxime are, therefore, crystalline solids.

Action of Alkyl Haloids.—Methyl bromide, and apparently other alkyl haloids, act on α-benzaldoxime, furnishing crystalline derivatives, which the authors are investigating.

*93. "The interaction of acid chlorides and nitrates." By Henry E. Armstrong and A. Lapworth.

It was shown by one of the authors in 1873 (*Chem. Soc. Journ.*, p. 683) that acetic chloride and nitrates interact, forming acetic oxide, and that a mixture of chlorine and nitric peroxide gases is evolved instead of the compound NO_2Cl, which at that time was supposed to be capable of existing: it was suggested that in the case of silver nitrate perhaps the initial change involved the formation of silver acetate, chlorine and nitric peroxide, and that silver chloride and acetic oxide were then formed by the interaction of the silver acetate and acetic chloride. These observations were confirmed in 1886 by W. C. Williams (*Chem. Soc. Trans.*, p. 222), in so far as the production of chlorine and nitric peroxide was concerned, but Lacowicz had meanwhile stated (*Ber.*, 1884, 1281; 1885, 2990) that the gaseous products of such interchanges are nitric peroxide and oxygen, a result which was not confirmed by Williams.

The authors have extended the observations in order to throw further light on the evolution of chlorine in such cases, and with the object of elucidating the function of chlorine in acid chlorides (*cf.* these Proceedings, 1891, 60). By displacing the air from the apparatus by carbon dioxide, and then passing the evolved gases first through oil of vitriol and afterwards through alkali contained in an apparatus such as is used in determining nitrogen, they have satisfied themselves that only chlorine and nitrogen peroxide are evolved. Quantitative experiments show that in the case of silver nitrate and acetic chloride half the chlorine is evolved and half retained as metallic chloride; but it would seem that chloride is only produced when the chloride used is capable of acting on the salt which is formed in the initial interaction: thus chlorosulphonic acid, $ClSO_3H$, and potassium nitrate afford little or no chloride, the nitrate being converted into acid sulphate. The results of experiments with a variety of acid chlorides and nitrates appear to justify the conclusion that the interaction is one involving the mere displacement of the chlorine of the chloride by oxygen from the nitrate; and, in point of fact, nitric anhydride is found to act in the manner to be expected on this assumption, at once converting acetic and benzoic chlorides into the corresponding oxides, chlorine and nitric peroxide. As nitric peroxide has no action on silver nitrate, and as nitrylic chloride has no existence, the formation of nitric anhydride by Deville's method must be considered to be a direct outcome of the interaction of silver nitrate and chlorine: and if silver nitrate be regarded as a compound of the formula $Ag_2O{\cdot}N_2O_5$—a view on behalf of which much may be said—it is conceivable that chlorine simply acts on the "silver oxide radicle," removing it from combination with the nitric anhydride, and consequently liberating the latter. The results obtained appear generally to support the conclusion that the chlorine in acid chlorides is not possessed of the special activity which is commonly attributed to it.

*94. "The freezing points of triple alloys." By C. T. Heycock and F. H. Neville.

Continuing their experiments on the freezing points of alloys, the authors find that gold and cadmium, which in previous experiments seemed to combine together to form a compound (AuCd), behave similarly when they are together dissolved in tin, bismuth, thallium or lead. The interaction of these metals appears, therefore, to be independent of the nature of the solvent.

Silver and cadmium, when dissolved together in different metallic solvents, give results resembling those obtained with gold and cadmium. Dissolved in tin or lead the maximum freezing point is reached when the ratio of the two metals is 2Ag : Cd, and in thallium the ratio is almost the same. With bismuth, however, the maximum freezing point is reached at the proportion 4Ag : Cd. The existence of metallic compounds having these formulæ seems to be probable.

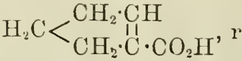
Aluminium, when dissolved with tin and gold, behaves as if it were composed of molecules of the composition Al_2. The maximum freezing point of a mixture of aluminium and tin to which gold has been added is identical with that of pure tin, and corresponds with the proportion $Al_2Au_{0\cdot 9}$. It appears probable from these results that a stable, insoluble compound ($AuAl_2$) is produced, the gold completely removing the aluminium from solution. This compound is apparently identical with Roberts-Austen's purple alloy of aluminium and gold.

*95. "Synthesis of pentamethylenecarboxylic acid, hexamethylenecarboxylic acid, hexhydrobenzoic acid and azelaic acid. By E. Haworth, B.Sc., and W. H. Perkin, Junr., F.R.S.

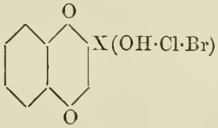
With the object of preparing hexhydrobenzoic acid synthetically by the interaction of pentamethylene dibromide and ethylic sodiomalonate, the authors followed the directions given by Gustavson and Demjanoff (*J. pr. Chem.*, **39**, 542) for the preparation of the dibromide from the diamine obtained by reducing trimethylene cyanide; they obtained from 1500 grams of trimethylene bromide only 90 grams of what was supposed to be pentamethylene bromide, but which, judging from the results obtained with it, chiefly consisted of tetramethylene bromide. The main product of the interaction of this bromide and ethylic sodiomalonate was 1 : 1-pentamethylenedicarboxylic acid, $C_5H_8(CO_2H)_2$. On distilling this acid, a monocarboxylic acid was obtained which was identified by direct comparison with that prepared by Wislicenus and Gärtner from the cycloid ketopentamethylene produced from adipic acid.

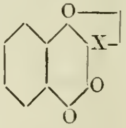
By distilling the oil from which the pentamethylenedicarboxylic acid had crystallised out, a higher fraction was obtained consisting of hexamethylenecarboxylic acid, which proved to be identical with the hexhydrobenzoic acid prepared by Aschan from benzoic acid.

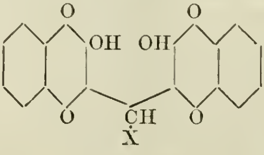
In addition to the two dicarboxylic acids derived from tetra- and penta-methylene bromides respectively and a single molecular proportion of malonate, a tetracarboxylic acid was also isolated which was derived from 1 mol. of pentamethylene bromide and 2 of malonate; on distillation, this acid was resolved into carbon dioxide and a heptanedicarboxylic acid which proved to be identical with azelaic acid prepared by oxidising Chinese wax.

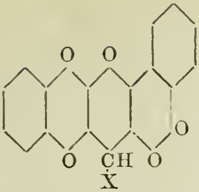
By brominating pentamethylenecarboxylic acid and then removing hydrogen bromide, a pentamethenylenecarboxylic acid was obtained identical with that prepared by Wislicenus and Gärtner from hydroxypentamethylenecarboxylic acid. This acid, which is represented by the formula  $\mathrm{H_2C}<\begin{array}{l}\mathrm{CH_2\cdot CH}\\ \mathrm{CH_2\cdot \overset{\|}{C}\cdot CO_2H}\end{array}$, resembles benzoic acid in appearance, and not only has the same melting point, but also sublimes with great readiness.

*96. "The conversion of ortho- into para-, and of para- into ortho-quinone derivatives. I. The condensation of aldehydes with β-hydroxy-α-naphthaquinone." By S. C. Hooker and W. C. Carnell.

Attention has been directed in previous communications on lapachol derivatives to the formation of anhydrides by the removal of water or of hydrogen chloride or bromide from compounds of the form 

It was found that the majority of the lapachols gave two isomeric anhydrides, the one an α-, the other a β-naphthaquinone derivative, while a few have afforded but a single anhydride derived from the β-quinone. In order to ascertain whether anhydrides of the form 

are generally produced, the authors have studied the behaviour of compounds synthetically prepared from aldehydes and β-hydroxy-α-naphthaquinone, such as were first obtained by Zincke and Thalen (*Ber.*, **21**, 2203). From some of these, small quantities of anhydrides were obtained by Schooch. The authors' experiments show that the conclusions arrived at by Zincke and his pupils that these anhydrides were α-quinone derivatives was incorrect, and that—as was to be anticipated from the results arrived at in the course of the lapachol research—they are in reality β-quinone derivatives, the formation of the anhydride also involving the passage of the α- into the β-quinone. It would appear probable that the compounds of the form 

derived from aldehydes and hydroxy-α-naphthaquinone, are converted into anhydrides of the form  , as when brought into contact with orthotoluylenediamine these anhydrides afford only *mon*azines. It has been shown that in the lapachol group both the α- and β-anhydrides are readily hydrated, and yield the same hydroxylapachol, a change which, in the case of the β-anhydrides, involves the reconversion of the ortho- into the para-quinone; the synthesised anhydrides behave similarly, but the change is more difficult to demonstrate, as the hydroxy-derivatives very rapidly undergo change in contact even with very dilute caustic soda—an interaction which is being studied in detail. The compounds dealt with are those derived from benzaldehyde, acetaldehyde, valeraldehyde and cuminic, salicylic and cinnamic aldehydes: in all cases the anhydrides obtained were orange or red compounds, yellow being the colour characteristic of the α-anhydride.

*97. "The synthesis of lapachol." By S. C. Hooker.

By heating hydroxynaphthaquinone dissolved in acetic acid together with valeric aldehyde and concentrated chlorhydric acid, the author has obtained an isomeride of lapachol crystallising in orange-red needles, which melts at 119—120°, and forms violet-coloured salts with alkali metals; its acetate melts at 74°. From this compound others have been obtained containing the same number of carbon atoms as lapachol, and identical with substances prepared from lapachol.

At the next meeting, on Thursday, January 18th, 1894, at 8 P.M., the following papers will be read:—

"The molecular formulæ of some liquids as determined by their molecular surface energy." By Professor Ramsay, F.R.S., and Miss Emily Aston, B.Sc.

"Contributions to our knowledge of the aconite alkaloids."

VIII. "On picraconitine." By Professor Dunstan and Mr. E. F. Harrison.

IX. "The action of heat on aconitine." By Professor Dunstan and Mr. F. H. Carr.

X. "Further observations on the conversion of aconitine into isaconitine." By Professor Dunstan and Mr. F. H. Carr.

"The interaction of benzylamine with ethylic chloracetate." By Drs. Mason and Winder.

"Condensation of benzylamine with benzenoid aldehydes." By Drs. Mason and Winder.

HARRISON AND SONS, PRINTERS IN ORDINARY TO HER MAJESTY, ST. MARTIN'S LANE.

PROCEEDINGS

OF

THE CHEMICAL SOCIETY.

Vol. X. Nos. 131—144.
JANUARY—DECEMBER, 1894.

EDITED BY THE SECRETARIES.

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1895.

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DATES OF ISSUE OF THE MONTHLY NUMBERS OF THE JOURNAL OF THE CHEMICAL SOCIETY TO FELLOWS.

January number was issued		30th January.
February	,,	6th February.
March	,,	15th March.
April	,,	12th April.
May	,,	18th May.
June	,,	13th June.
July	,,	30th July.
August	,,	4th August.
September	,,	4th September.
October	,,	9th October.
November	,,	5th November.
December	,,	17th December

LIST OF GRANTS MADE FROM THE RESEARCH FUND DURING THE YEAR.

£47 to Mr. A. E. Tutton for apparatus and chemicals to continue his comparative crystallographical study of certain salts.

£10 to Dr. James Walker for the investigation of the products obtained by the electrolysis of potassium ethyl salts of tetrabasic organic acids.

£25 to Mr. Herbert Jackson for apparatus and materials to continue his researches on the nature of phosphorescence.

£10 to Mr. W. A. Bone for the continuation of an investigation on the trimethylsuccinic acids.

£20 to Dr. George Tate for experiments on the ferment action of bacteria under varied conditions.

£20 to Professor W. R. Dunstan for the investigation of the interaction of alkyl iodides and hydroxylamines.

LIST OF FELLOWS ELECTED DURING 1894.

Name.	Proposed.	Elected.
Alhusen, F. E.	February 1st	May 3rd.
Allen, Frederick J.	November 1st	December 6th.
Allibon, George H.	,, ,,	,, ,,
Allport, John	,, ,,	,, ,,
Ashcroft, J. Benyon	February 15th	May 3rd.
Ashdown, Charles H.	February 1st	,, ,,
Asher-Aron, S. Bernard	February 15th	,, ,,
Bamber, William E.	November 16th, 1893	February 15th.
Barlet, Stephane	November 1st	December 6th.
Bird, William R.	November 16th, 1893	February 15th.
Blackmore, H. Spencer	June 7th	December 6th.
Bose, Chuni Lal	November 16th, 1893	February 15th.
Boul, William Good	January 18th	,, ,,
Bowes, Harry	February 1st	May 3rd.
Boyd, D. R.	November 1st	December 6th.
Brame, J. S. Strafford	,, ,,	,, ,,
Bruce, James	,, ,,	,, ,,
Burgess, Herbert E.	January 18th	February 15th.
Burman, G. William	November 1st	December 6th.
Bush, William	,, ,,	,, ,,
Buttermer, Robert W.	March 1st	May 3rd.
Cain, J. Cannell	November 16th, 1893	February 15th.
Cameron, Alexander	June 21st	December 6th.
Catherall, Ezra	November 1st	,, ,,
Chambers, Joseph F.	June 7th	,, ,,
Chambers, Thomas	February 1st	May 3rd.
Chattaway, F. D.	November 16th, 1893	February 15th.
Coote, A. Herbert	November 1st	December 6th.
Dains, Herbert H.	January 18th	February 15th.
Davies, Samuel H.	November 16th, 1893	,, ,,
Dixon, George	March 15th	June 7th.
Doherty, W. Michael	November 1st	December 6th.
Donald, George	April 19th	June 7th.
Duncan, C. Cooke	May 17th	December 6th.
Duncan, Dr. John	November 16th, 1893	February 15th.
Dunn, Frederic	June 7th	December 6th.
Dunne, Basil L.	January 18th	February 15th.
Dutson, L. B. Saltwell	November 1st	December 6th.
Eumorfopoulos, Nicholas	March 15th	June 7th.
Evershed, Frank	November 16th, 1893	February 15th.
Fawcett, J. Addey	January 18th	February 15th.
Fitzgerald, H. Purefoy	December 7th, 1893	,, ,,
Flintoff, Robert J.	April 19th	June 7th.
Fogg, Charles A.	June 21st	December 6th.
Forbes, D. Gordon	May 17th	,, ,,
Gabb, G. Hugh	March 1st	May 3rd.

Name.	Proposed.	Elected.
Ghasvala, Bhikaji Edalji	May 17th	June 7th.
Golden, Arthur R.	February 1st	May 3rd.
Grafton, Walter	December 21st, 1893	February 15th.
Greeves, Alfred	November 1st	December 6th.
Hadley, Arthur	May 3rd	June 7th.
Hall, John	November 1st	December 6th.
Hamilton, Robert	December 21st, 1893	February 15th.
Harris, S. Walters	April 19th	June 7th.
Harrison, Edward F.	November 16th, 1893	February 15th.
Harvey, W. Pellew	December 21st, 1893	February 15th.
Haworth, Edward.	November 1st	December 6th.
Hayward, R. Stanley	January 18th	February 15th.
Helms, Albert	November 1st	December 6th.
Hewitt, Oswald E. W.	February 15th	May 3rd.
Higgs, M. Stanger	June 6th	December 6th.
Hills, Edmond H.	November 16th, 1893	February 15th.
Hirsch, Charles T. W.	February 15th	May 3rd.
Hitchens, J. H.	April 19th	June 7th.
Hogg, Alexander F.	November 1st	December 6th.
Holmes, J. Winder	November 16th, 1893	February 15th.
Holt, Wilmot, jun.	April 19th	June 7th.
Hope, A. Peach	„ „	„ „
Hornby, R.	December 21st, 1893	February 15th.
Hughes, Frank	December 7th, 1893	February 15th.
Hutchinson, Alfred	„ „ „	„ „
Jackman, Edwin J.	February 15th	May 3rd.
Jackson, D. Hamilton	November 16th, 1893	February 15th.
Jardine, Walter	December 21st, 1893	„ „
Jaubert, George F.	November 16th, 1893	„ „
Jenks, R. Leonard	„ „ „	„ „
Jennison, Francis H.	January 18th	„ „
Jones, G. Cecil	November 1st	December 6th.
Kellas, A. Mitchell	February 15th	May 3rd.
Knight, James	June 7th	December 6th.
Ladell, Richard S.	May 17th	December 6th.
Lapworth, A.	November 16th, 1893	February 15th.
Lean, Bevan	November 1st	December 6th.
Lee, Clifford W.	December 21st, 1893	February 15th.
Leonard, Norman	„ 7th, 1893	„ „
Lewis, W. H.	November 1st	December 6th.
Lucas, E. W.	January 18th	February 15th.
Luty, Arthur	December 7th, 1893	„ „
Macdonald, A. H.	December 7th, 1893	February 15th.
MacDonald, George W.	November 1st	December 6th.
Makin, C. J. Shaw	„ „	„ „
McCutcheon, James	„ „	„ „
McLeod, James	April 19th	June 7th.
McMullan, Charles	February 1st	May 3rd.
Melland, Godfrey	November 16th, 1893	February 15th.
Murray, J. M.	„ „ „	„ „

Name.	Proposed.	Elected.
Newth, G. S.	March 15th	June 7th.
Nixon, Alfred	,, ,,	,,
Ormerod, Thomas	November 1st	December 6th.
Parker, G. L.	May 3rd	June 7th.
Parker, Matthew A.	March 1st	May 3rd.
Paterson, David.	December 7th, 1893.	February 15th.
Paulusz, Richard	November 16th, 1893	,, ,,
Pearson, William H.	,, ,, ,,	,, ,,
Peden, John, jun.	December 21st, 1893	,, ,,
Pike, E. Brooke	April 19th	June 7th.
Pollok, J. Holmes	November 16th, 1893	February 15th.
Quinn, Gerald G.	November 1st	December 6th.
Quinn, J. Cardwell	December 7th, 1893.	February 15th.
Riddick, David Gibson	November 1st	December 6th.
Roberts, Thomas J.	February 15th	May 3rd.
Robertson, A. B.	December 21st, 1893	February 15th.
Robjohns, H. Harold	March 15th	June 7th.
Rolfe, John F.	May 3rd	,, ,,
Ross, Arthur	December 7th, 1893	February 15th.
Rouillard, Richard A.	,, ,, ,,	,, ,,
Rowntree. W. Smithson	,, ,, ,,	,, ,,
Ryce, George	March 15th	June 7th
Scorer, Alfred G.	November 1st	December 6th.
Shorthouse, H. Stephen	April 19th	June 7th.
Shuttleworth, Prof. Edward B.	,, ,,	,, ,,
Smith Claude	November 1st	December 6th.
Smith, Charles H.	December 7th, 1893.	February 15th.
Smith, Ernest A.	April 19th	June 7th.
Spenzer, John G.	March 15th	,, ,,
Steel, Robert W.	April 19th	,, ,,
Stoddart, F. Wallis	February 1st	May 3rd.
Swinburne, James	March 1st	,, ,,
Tanner, Alfred E.	December 7th, 1893.	February 15th.
Taylor, Albert	November 1st	December 6th.
Taylor, Herbert J.	May 3rd	June 7th.
Terry, Edwin	February 1st	May 3rd.
Thompson, E. Cumming	March 15th	June 7th.
Thudichum, G. Dupré	April 19th	,, ,,
Trench, George	November 16th, 1893	February 15th.
Vaux, Cuthbert	June 7th	December 6th.
Wagner, William G.	November 1st	December 6th
Walker, Charles H. H.	May 3rd	June 7th.
Warren, William L.	November 1st	December 6th.
Waterfield, A. Swainson	March 15th	June 7th.
Waterhouse, Robert	November 1st	December 6th.
Wheeler, Henry L.	February 1st	May 3rd.
Williams, W. Lloyd	December 21st, 1893	February 15th.

Name.	Proposed.	Elected.
Wilson, A. Poole	November 1st	December 6th.
Wilson, Christopher	,, ,,	,, ,,
Wilson R. Hanbury	,, ,,	,, ,,
Wingate, Hamilton M.	December 7th, 1893.	February 15th.
Wright, Robert	April 19th	June 7th.
Young, James	November 1st	December 6th.
Young, Meredith	November 16th, 1893	February 15th.

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Name.	Elected.	Died.
Ashwell, J. R.	December 15th, 1870	
Bell, H. Stowe	June 21st, 1877	March 23rd, 1894.
Bickett, J. H.	May 4th, 1882	
Brown, J. T.	April 19th, 1866	
Barratt, A.	May 5th, 1892	
Beauchamp, Major	December 1st, 1864	1889.
Board, G.	May 1st, 1883	April 29th, 1894.
Carteighe, John	January 17th, 1853	April, 1894.
Dunne, B. L.	February 15th, 1894	August, 1894.
Gill, C. H.	April 3rd, 1862	
Helmholtz, Professor	February 1st, 1883	September 8th, 1894.
Marignac, J. C. J.	June 19th, 1862	April 15th, 1894.
Morris, J. E.	December 3rd, 1874	April 9th, 1894.
Salet, G.	February 19th, 1880	
Smith, S. J.	March 17th, 1870	
Thornton, H. B.	May 15th, 1888	
Twining, A. H.	December 2nd, 1886	
Thornthwaite, W. H.	May 4th, 1858	February 20th, 1894.
Titmas, Rev. S. D.	December 5th, 1872	August, 1894.
Woodland, John	February 7th, 1878	
White, A.	June 2nd, 1851	
Wright, Dr. C. R. A.	June 7th, 1866	July, 1894.

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104. Constitution of rubiadin. By Edward Schunck, Ph.D., F.R.S., and Leon Marchlewski, Ph.D.	10	182
105. The monalkyl ethers of alizarin. By Edward Schunck, Ph.D., F.R.S., and Leon Marchlewski, Ph.D.......	10	185
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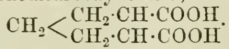
58. Pentamethylenedicarboxylic acid,  $CH_2<\begin{matrix}CH_2\cdot CH\cdot COOH\\CH_2\cdot CH\cdot COOH\end{matrix}$. By E. Haworth, B.Sc., and W. H. Perkin, jun., F.R.S.	183	—
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PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

No. 132. Session 1893–94.

January 18th, 1894. Dr. Armstrong, President, in the Chair.

Messrs. J. E. Brockbank, Charles Sordes Ellis, William Hatten Grieve and Claude Vautin were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. William Good Boul, M.A., Churcher's College, Petersfield; Herbert Edward Burgess, 144, Warwick Street, Eccleston Square, S.W.; Herbert Henry Dains, 3, Cantonment, Vizianagram, Madras Presidency; Basil Leonard Dunne, 64, Lower Leeson Street, Dublin; Joseph Addey Fawcett, 153, Malpas Road, Brockley, S.E.; Edward Stanley Hayward, 23, St. Thomas Street, Winchester; Isaac Henry Heap, Fern Bank, Aynsley Road, Stoke-on-Trent; Francis Herbert Jennison, c/o A. Delingworth, Moscow, Russia; E. W. Lucas, 225, Oxford Street; Harvey Ernest Spillard, 5, Belitha Villas, Barnsbury Park.

Of the following papers those marked * were read:—

***98. "The molecular formulæ of some liquids as determined by their molecular surface energy." By Emily Aston, B.Sc., and William Ramsay, PhD., F.R.S.**

The molecular surface energy and its variation with temperature of phenol, bromine, nitric acid, sulphuric acid, phosphorus and nitrotrichloromethane have been determined by the authors by the method described by Ramsay and Shields (Trans., 1893, 1089). The data given make it possible to calculate the molecular weights of the substances in the liquid state.

Phenol, as might be expected from its analogy with alcohol, is an associating substance; but as it possesses a fairly high molecular weight, the degree of association is not great; the results serve to suggest that between 46° and 78° it possesses the mean molecular weight 133·5, while in the state of gas its molecules have the weight 94.

Bromine, apparently, is somewhat more condensed than the formula Br_2 would imply, the number found being 202·8 instead of 160, between 10·6° and 46°.

Nitric acid, instead of possessing the molecular weight 63, has a molecular complexity corresponding to the weight 105·9 between 11·6° and 46·2°. This value approximates to that corresponding to the formula $H_2N_2O_6$.

Sulphuric acid shows a remarkable behaviour. From atmospheric temperature to 132·5° its molecule, apparently, is approximately 32 times as complex as the formula H_2SO_4 would imply; above 132°, however, dissociation rapidly ensues, and between 227° and 281° the molecule is only 2·8 times as complex as the formula H_2SO_4 implies.

The molecules of phosphorus in the liquid state, like those of the gas, have the formula P_4.

Chloropicrin, $CCl_3(NO_2)$, has a normal molecular weight. This result stands in opposition to that afforded by nitroethane, which shows signs of association.

DISCUSSION.

Mr. PICKERING said that the importance of obtaining various methods of determining the molecular complexity of substances in the liquid condition could scarcely be overrated; but he thought that it would be premature to attach implicit faith to the results obtained by Professor Ramsay's method until the discrepancies between the values given by it and other methods were explained or removed. The results which Professor Ramsay had obtained in some cases showed that it would be unwise to place too much confidence in his method at present, for he had found that a considerable number of substances gave values which, though constant throughout a wide range of temperature, yet indicated molecular weights which were not integral multiples of the formulæ weights.

The authors' results in the case of sulphuric acid were of interest in connection with those he had arrived at by determining the densities of solutions of this substance: from the peculiarity of the figure formed on plotting out their values (these forming a straight line throughout a considerable range, and a well marked curve throughout the rest of the range), the authors concluded that $32H_2SO_4$ might represent the state of aggregation of the acid, whereas his results pointed to $36H_2SO_4$ (within experimental error the same degree of complexity), the lowest hydrate of which he had obtained indications containing acid and water in the ratio 36 : 1 ; moreover, in all the other low hydrates the acid molecules were present as simple submultiples of 36.

Mr. RODGER said there were two points in connection with Professor Ramsay's paper to which attention might be drawn. The first was of historical interest and referred to the work of Eötvös, which did not seem to be given the prominence which it deserved. In 1885 Eötvös showed that over wide temperature ranges K, the rate at which molecular surface energy varied with the temperature, was practically the same for liquids of different chemical natures, and these substances he held to be of the same molecular complexity in the states of gas and liquid. For the acids, alcohols and water, K varied with the temperature and the chemical nature, and in such cases Eötvös concluded liquid molecular complexes were present. The equation which Eötvös *derived* by integrating the differential equation above mentioned only differed from the corresponding expression given by Professor Ramsay in that it does not accurately indicate the temperature limits at which it breaks down.

Eötvös's method of estimating complexity is identical, however, with that of Professor Ramsay, and so far as they go, his observations lead to like results. For these reasons, should the credit of instituting this method not be ascribed to Eötvös ?

The second point referred to the validity of the method. In the first place, neither Ramsay nor Eötvos had succeeded in placing the method on a firm theoretical basis. Eötvös's expression was deduced from van der Waals's generalisation that for two substances A and B, in corresponding states, $\frac{P_A V_A}{T_A} = \frac{P_B V_B}{T_B}$, where P, V and T are respectively the pressure, molecular volume and temperature. In criticising Eötvös's method (*Zeit. phys. Chem.*, 1893) Professor Ramsay has characterised this relation as false, and although in the light of Young's recent work this is, perhaps, going too far, its agreement with experimental results is not sufficiently close to be regarded as a proof that K is really a measure of complexity. By way of such a proof Professor Ramsay has pointed out that inasmuch as the rate of change of the molecular volume energy of a perfect gas is the same for all gases, provided they contain molecules of the same degree of complexity, probably the rate of change of the molecular surface energy of a liquid is also the same for all liquids which are of the same molecular complexity. This can hardly be regarded as a proof, however, because the gas equation breaks down as soon as the gas is compressed—as soon, that is, as the molecules come within the sphere of each other's attraction, and it is precisely this attraction which is involved in the phenomena of surface energy. How is it possible, therefore, to draw any satisfactory conclusion from the behaviour of a perfect gas regarding the molecular mechanism of a liquid surface?

In the second place, it may be argued that even although it could be established theoretically that K should be the same for substances of the same molecular complexity, experiment indicates that this is not really the case.

Professor Ramsay's results show that K varies with the chemical nature of the substance. The extreme values for liquids the simple molecules of which are assumed to be unassociated differ by some 17 per cent. Moreover, there is also evidence that in the case of the same liquid K varies with the temperature. The data for the six liquids examined over wide temperature ranges by Professor Ramsay, especially those for ethylic acetate, seem to show that the theoretical straight curve for molecular surface energy cuts the observed curve generally in two points; the differences between theory and practice being, no doubt, small but regular. If this be really the case, the slope of the curves, that is K, must vary with the temperature. But if K varies in this way, how are we to ascertain what value corresponds with an unassociated substance? In short, is it not rather premature in the present state of the question to definitely assess the weights of liquid molecules?

Professor Ramsay, in replying to Mr. Pickering, pointed out that the method of determining the molecular weights of liquids from variation of their surface energy could hardly be said to stand on a footing with those which involved osmotic pressure; in the one case, it is the behaviour of molecules widely separated from one another by molecules of a solvent which causes them to behave as gases, and to be practically independent of their mutual attraction; while in the other, it is this very attraction which makes it possible to determine the molecular weight of an undiluted liquid. It would be as unreasonable to expect the molecular weights of dissociating substances measured by these two methods to be identical as it would be to expect identity in the weights of the molecules of nitric peroxide measured at two widely different pressures.

He understood Mr. Pickering to refer to the comparative constancy of the molecular weights of such substances as butyric acid over considerable ranges of temperature. This is no doubt partly to be attributed to experimental error, but it no doubt implies only a small increase of dissociation with rise of temperature.

The number given for the multiple of H_2SO_4—32—might well be some units higher or lower.

In replying to Mr. Rodger, Professor RAMSAY said that it was explicitly stated in the paper by Dr. Shields and himself in the *Philosophical Transactions*, that Eötvös's conclusion as regards the constancy of the temperature coefficient of molecular surface energy is true between wide ranges of temperature; and he would be very sorry if it were thought that credit were not due to Eötvös for his exceedingly ingenious work; especially for the brilliant conception of molecular surface. Exception was taken, first, to the method in which Eötvös deduced his theoretical conclusions, which are manifestly untenable; and also, probably owing to Eötvös's very imperfect means of securing high temperatures, to the equation from which the differential coefficient was derived. But Eötvös's conclusions, as well as his actual results, were quoted in full, and it is explicitly stated that Eötvös also made measurements with methyl and ethyl alcohols, and recognised that their approximate molecular weights might be calculated from their irregular behaviour; but his observations are not sufficient in number (Trans., 1893, 1107). Conclusions drawn from the examination of more than 60 substances were surely more trustworthy than those drawn from eight, especially if some of the eight observations are heavily weighted with temperature errors.

Moreover, the credit of having first clearly pointed out that this "colligative" property is at present the only one by which the molecular weights of liquids could be determined is due to Ostwald, who devotes to it several paragraphs in his *Lehrbuch*.

With reference to Mr. Rodger's criticism on the impropriety of drawing any conclusions regarding the molecular weight of liquids from their surface energy, based on the idea that Dr. Shields and he use the gas equation as a proof of the correctness of their method, this criticism was due to a misconception. The *analogy* was pointed out, but no attempt was made to construe it as a *proof*. That the simple gas equation is no longer valid when the liquid state is reached; that P is no longer equal to RT/V; such considerations cannot be urged to have any bearing on the fact that $\gamma = k(\tau - d)/v^{\frac{2}{3}}$. That a "push" given to a gas ceases, as the liquid state is approached, to obey a simple law cannot be urged as a reason why a "pull" given to a liquid should not be expressed by a simple equation.

It is true that k varies with the nature of the substance within certain limits, but so does R, the gaseous constant. And it is probable, indeed certain, that the configuration of the molecule should have a greater influence on the value of k than on the value of R, because in the liquid state the molecules are so much more closely packed. Experiments are in progress to discover the amount of variation of k, as chemical structure and composition vary.

As regards the non-constancy of k for any one liquid, that was fully alluded to in the original memoir in the *Philosophical Transactions*, and a formula is there given which approximately represents the variation from linearity at temperatures near, and also below, the critical point. Mr. Rodger's remarks, however, tended greatly to exaggerate this variation, which in no case exceeds 0·5 per cent., within reasonable distance of the critical point.

It was to be expected that in a preliminary investigation of the kind, certain discrepancies should be encountered, which will, doubtless, find their explanation later. But the examination of about 60 substances has shown that those which have normal gaseous densities possess a monomolecular formula in the liquid state; that the fatty acids, which exhibit a vapour density which implies association, also exhibit association when in the liquid state; and that other hydroxyl compounds, such as water and the alcohols, which the recent investigation of Dr. Sydney Young, with data furnished by himself alone, and by joint work with the speaker, have shown to exhibit abnormal behaviour near their critical points, only explicable on the theory of association, also exhibit molecular complexity in the liquid state. In the speaker's opinion, a strong case was made out by these surface energy experiments in favour of the justice of the hypothesis which had been advanced.

*99. "Contributions to our knowledge of the aconite alkaloids. VIII. On picraconitine." By Wyndham R. Dunstan, M.A., F.R.S., and E. F. Harrison.

Through the kindness of Mr. F. B. Groves, of Weymouth, the authors have been enabled to examine specimens of salts of picraconitine, an amorphous alkaloid obtained by Mr. Groves, in the year 1874, from the roots of *Aconitum Napellus*, the composition and properties of which were subsequently investigated by Dr. Wright (*Journ. Chem. Soc.*, 1877, 146; 1878, 332). Its composition was represented by the formula $C_{31}H_{45}NO_{10}$, that of aconitine being $C_{33}H_{43}NO_{12}$. It furnished crystalline salts and an amorphous aurichloride. When heated with alkalis, it underwent hydrolysis, yielding equimolecular proportions of benzoic acid and picraconine, a base closely resembling aconine, the similar product from aconitine. Picraconitine was sparingly soluble in water, but readily in ether. Its salts have an intensely bitter taste, whence the names given to the substance, but they do not produce tingling of the tongue and lips which is so characteristic of aconitine. Mr. Groves had not previously obtained this alkaloid from other collections of the roots of this plant, and neither he nor Dr. Alder Wright was able to isolate it subsequently. It has, therefore, been suggested that it originated from the roots of some other species of aconite which were mixed in this collection with those of *A. Napellus*. In the course of the present investigation of the alkaloids of *A. Napellus*, no alkaloid having the composition of "picraconitine" has been obtained. Picraconitine, however, in many of its properties resembles the isomeride of aconitine, isaconitine. The fact that this isomeride is difficult to purify, except by adopting special methods, suggested the view that "picraconitine" might be impure isaconitine. An examination of Mr. Groves's specimens of "picraconitine nitrate" and "picraconitine muriate" has confirmed this view. The base regenerated from these salts exhibited all the properties of isaconitine, and on converting it into the hydrochloride and purifying this salt, first by crystallisation from hot water and afterwards from a mixture of alcohol and ether, pure isaconitine hydrochloride, melting at 217°, was obtained. In order to complete the proof the characteristic aurichlorisaconitine, $C_{33}H_{44}(AuCl_2)NO_{12}$, was prepared from the "picraconitine" salts. "Picraconitine" can therefore no longer be retained as the name for an alkaloid derived from *A. Napellus*. The present investigation has shown that this plant contains, besides *aconitine* and the non-toxic *isaconitine*, and *aconine*, a very small quantity of an amorphous alkaloid yielding crystalline salts, which has been named *homisaconitine*, and generally a considerable quantity of a base which neither crystallises nor furnishes crystalline salts.

*100. "Contributions to our knowledge of the aconite alkaloids. IX. The action of heat on aconitine." By Wyndham R. Dunstan, M.A., F.R.S., and F. H. Carr.

The authors find that when aconitine is heated at its melting point (188—190°) it loses about 10 per cent. of acetic acid, which distils over, leaving a new alkaloid which they propose to name *pyraconitine*, $C_{33}H_{45}NO_{12} = C_2H_4O_2 + C_{31}H_{41}NO_{10}$.

Pyraconitine is obtained in the form of an amorphous varnish, sparingly soluble in water, but readily in alcohol, chloroform and ether. It has no effect on polarised light, and is not poisonous in small doses. The alkaloid readily dissolves in acids, forming salt which can be crystallised.

Pyraconitine hydrobromide, $C_{31}H_{41}NO_{10}\cdot HBr$, forms prismatic crystals melting at 280° (corr.). The salt is readily soluble in water and alcohol, but is not dissolved by ether. It is best crystallised from a mixture of alcohol and ether. In aqueous solution it is lævorotatory: $[\alpha]_D = -46{\cdot}47°$.

Pyraconitine hydrochloride. $C_{31}H_{41}NO_{10}{\cdot}HCl$, crystallises in rosettes from a mixture of alcohol and ether. It melts at 249°.

Pyraconitine hydriodide, $C_{31}H_{41}NO_{10}{\cdot}HI$, also crystallises in rosettes, which become yellow when exposed to air. It melts at 220·5° (corr.).

The solutions of these salts have a bitter taste, but are not toxic, at all events in small doses.

Pyraconitine aurichloride. $C_{31}H_{41}NO_{10}{\cdot}HAuCl_4$, is thrown down as a pale yellow precipitate when auric chloride is added to a solution of the hydrochloride. No aurichlor-derivative could be obtained.

Pyraconitine and its salts readily undergo hydrolysis when heated with dilute acid or with water in a closed tube. Potash and soda quickly hydrolyse the alkaloid, even in the cold, but ammonia does so only very slowly. The sole products of hydrolysis are *benzoic acid* and an alkaloid which has been named *pyraconine*, $C_{31}H_{41}NO_{10} + H_2O = C_7H_6O_2 + C_{24}H_{37}NO_9$.

Pyraconine is an amorphous base resembling aconine in its properties, but differing from it in several respects. It is soluble in both water and ether. The aqueous solution has a somewhat sweet taste, and is lævorotatory $[\alpha]_D = -90{\cdot}99°$. It combines with acids to form crystalline salts which are very soluble in water.

Pyraconine hydrochloride, $C_{24}H_{37}NO_9,HCl$, crystallises from water in cubes containing 1 mol. of water. It melts at 159° (corr.), and is soluble both in alcohol and in water. The aqueous solution is lævorotatory: $[\alpha]_D = -102{\cdot}07°$.

Pyraconine aurichloride, $C_{24}H_{37}NO_9{\cdot}HAuCl_4$, is a pale yellow, amorphous precipitate.

The salts of aconitine also furnish pyraconitine, losing acetic acid when heated at about 190°. Isaconitine and aconine, however, do not undergo a similar decomposition. The authors consider it probable that the production of acetic acid from aconitine may serve as the basis of a process for the estimation of this alkaloid.

*101. "Contributions to our knowledge of the aconite alkaloids. X. Further observations on the conversion of aconitine into isaconitine." By Wyndham R. Dunstan, M.A., F.R.S., and F. H. Carr.

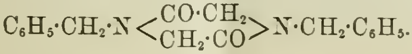
In a former communication, the authors showed that when certain aconitine salts are heated at 100° in slightly acid solution they are very slowly changed into the salts of isaconitine. They have since found that this conversion may be effected with great rapidity by heating a neutral aqueous solution in a closed tube at 120—130° during from two to three hours, when the aconitine salt disappears, often so completely that the solution produces a tingling sensation on the tongue. The isaconitine is separated from the solution which has been rendered alkaline with ammonia by repeated extraction with ether.

It has also been proved that the production of isaconitine invariably precedes the hydrolysis of aconitine into aconine and benzoic acid, not only when the hydrolysis is effected by acid, as was pointed out in a previous paper, but also, as has now been found, when water alone is used as the hydrolytic agent. In previous experiments, the formation of isaconitine during the hydrolysis of aconitine in presence of alkali could not be proved, owing to the rapidity with which aconine is produced. If, however, a considerable excess of an aqueous solution of soda be added to a solution of an aconitine salt, and the precipitated alkaloid be allowed to stand in contact with the cold alkaline solution until some of the alkaloid is dissolved, extraction with ether separates a notable quantity of isaconitine, as well as the unchanged aconitine. It therefore appears that the non-toxic aconine is really the product of the hydrolysis of the non-toxic isaconitine into which the aconitine first changes.

The observations recorded in the foregoing paper, which prove that aconitine salts as well as the alkaloid lose acetic acid when they are heated, led the authors to look for the production of this acid when solutions of these salts are heated. It has been found that some acetic acid is formed when aconitine salts are heated with water in the manner above described, and also when these salts or the alkaloid are hydrolysed. They are at present engaged in investigating the origin and amount of the acetic acid produced under various conditions, and also in determining whether pyraconitine is formed in corresponding quantity or whether aconitine may not be an acetyl derivative which loses its acetyl group on hydrolysis. If the latter view should prove to be correct, the nomenclature and formula of aconitine derivatives will need entire revision.

102. "Interaction of benzylamine and ethylic chloracetate." By A. T. Mason, Ph.D., and Goodlatte R. Winder, Ph.D.

The action of benzylamine on ethylic chloracetate is similar to that of ammonia and methylamine, the first product being the ethylic salt of benzylamidoacetic acid, $PH\cdot CH_2\cdot NH\cdot CH_2\cdot CO_2Et$, which, however, undergoes condensation, even at the ordinary temperature, two molecules of the ethylic salt uniting, and two molecules of alcohol being formed together with dibenzyl α-γ-diacipiperazine,



$$C_6H_5\cdot CH_2\cdot N<\genfrac{}{}{0pt}{}{CO\cdot CH_2}{CH_2\cdot CO}>N\cdot CH_2\cdot C_6H_5.$$

103. "Condensation products from benzylamine and several benzenoid aldehydes." By A. T. Mason, Ph.D., and Goodlatte R. Winder, Ph.D.

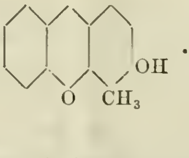
The products obtained are similar in their properties and mode of formation to those obtained from the primary paraffinoid and benzenoid amines and the benzenoid aldehydes. The following are described:—

Benzylidenebenzylamine, $C_6H_5{\cdot}CH_2{\cdot}N{:}CH{\cdot}C_6H_5$.
o-Hydroxybenzylidenebenzylamine, $C_6H_5{\cdot}CH_2{\cdot}N{:}CH{\cdot}C_6H_4{\cdot}OH$.
p-Hydroxybenzylidenebenzylamine, $C_6H_5{\cdot}CH_2{\cdot}N{:}CH{\cdot}C_6H_4{\cdot}OH$.

104. "Constitution of rubiadin." By Edward Schunck, Ph.D., F.R.S., and Leon Marchlewski, Ph.D.

The authors arrive at the conclusion that rubiadin does not contain a methoxy-group, but has a methyl group attached to the nucleus, as it does not yield methyl iodide on distillation with iodhydric acid and also remains unchanged when heated with concentrated sulphuric acid at 180°. It was found, moreover, that when oxidised with chromic acid, it gives phthalic acid, from which it may be inferred that the methyl and hydroxyl groups are attached to the same nucleus. These and other facts, such as those described in their first communication, render it certain that rubiadin cannot be identical with any possible methylalizarin or methylquinazarin, and that it must be regarded as a methylpurpuroxanthin.

Two alternative formulæ are therefore proposed. By condensing benzoic acid with metadihydroxyparatoluic acid a substance was obtained which had many properties in common with rubiadin, but differed as regards melting point and the melting points of the respective acetyl derivatives. This decided the authors in favour of the second formula given by them, viz.,



105. "The monalkyl ethers of alizarin." By Edward Schunck, Ph.D., F.R.S., and Leon Marchlewski, Ph.D.

Monomethylalizarin melts at 228—229° and yields an acetyl derivative melting at 186—187°. Monethylalizarin melts at 188—189°; its acetyl derivative at 141°. It is pointed out that in these compounds the alkyl has probably displaced the hydrogen atom in the β-OH group in alizarin. Experiments were made with a view to obtain ethers of alizarin isomeric with these, but without success.

106. "Ruberythric acid." By Edward Schunck, Ph.D., F.R.S., and Leon Marchlewski, Ph.D.

This glucoside, like all glucosides hitherto known, is not acted on by phenylhydrazin, and therefore does not contain an aldehyde group. Its constitution must, therefore, be represented in accordance with the formula of Tollens for glucose. When subjected to the action of benzoyl chloride in presence of sodic hydrate, ruberythric acid yields, according to the concentration of the soda solution, either a hepta- or a hexa-benzoyl derivative.

107. "The colouring matter of the Indian dye-stuff 'Tesu.'" By J. J. Hummel and W. Cavallo, Ph.D.

This yellow dye stuff consists of the dried flowers of *Butea frondosa*. The dyeing power of the flowers as sold is comparatively slight, but is increased by boiling with diluted acid, the glucoside of the dye stuff becoming hydrolysed.

By boiling the aqueous extract with sulphuric acid, then extracting with ether, and purifying the product by crystallising it from alcohol and water, the authors have obtained about 1 per cent. of a substance crystallising in almost colourless needles melting, when rapidly heated, at 217°. On analysing this, numbers were obtained ($C = 65{\cdot}5$ and $65{\cdot}65$; $H = 4{\cdot}93$ and $4{\cdot}67$) corresponding with the formula $C_{15}H_{14}O_5$. A large quantity of material is now being operated on.

ADDITIONS TO THE LIBRARY

I. *Donations.*

Die Schwingungsknoten-Theorie, von M. N. Teplow: aus dem Russischen übersetzt von L. Jawein. Zwei Lieferungen. St. Petersburg 1885–86. From the Author.

Benzène, Toluène et Anthracène, par W. N. Teploff. St. Petersburg 1893. (In Russian.) From the Author.

Die Chemie und das Problem von der Materie, von J. Wislicenus. Leipzig 1893. From the Author.

II. *By Purchase.*

Contribution a l'étude des gommes laques des Indes et de Madagascar, par A. Gascard: suivie d'une note de T. Tozzetti sur les Cochenilles à laque. Paris 1893.

Siede- und Schmelzpunkt, ihre Theorie und praktische Verwerthung; mit besonderer Berücksichtigung organischer Verbindungen, von W. Nernst und A. Hesse. Braunschweig, 1893.

Anleitung zur electro-chemischen Versuchen, von F. Vettel. Freiberg 1893.

Technisch-thermochemische Berechnungen zur Heitzung, insbesondere mit gasformigen Brennstoffen, von A. Naumann. Braunschweig 1893.

Die Kohlenstoff-Assimilation in historischer Darstellung, von X. Wellerwald. Basel 1893.

Animal and Vegetable Fixed Oils, Fats, Butters and Waxes, their preparation and properties and the manufacture therefrom of Candles, Soaps, and other Products, by C. R. A. Wright. London 1893.

At the next meeting, on February 1st, the following papers will be read :—

" The production of chlorine during the interaction of potassium chlorate and manganese dioxide." By Professor McLeod, F.R.S.

" An examination of some recent freezing point determinations." By S. U. Pickering, F.R.S.

" The salts of dehydracetic acid." By Dr. Collie and Mr. H. R. Le Sueur, B.Sc.

" A new method of preparing carbon tetrabromide." By Dr. Collie.

CERTIFICATES OF CANDIDATES FOR ELECTION AT THE NEXT BALLOT.

N.B.—The names of those who sign from "General Knowledge" are printed in *italics.*

The following Candidates will be balloted for on February 15th, 1894:—

Anderson, David,

14, St. Julian's Road, Kilburn, N.W.

Chemist. I have passed the Major Examination of the Pharmaceutical Society of Ireland, and I have been a student of Chemistry and Physics for three years, part of which time was spent under Dr. A. B. Griffiths.

Harold Follows.
Alexander Hay.
Richard Weaver.
E. C. Conrad.
A. B. Griffiths.
Lionel Cooper.
C. T. Kingzett.
A. H. Luckett.
C. A. MacMunn.

Bamber, William Edward,

Spring Lawn, Heaton, Bolton.

Research Student in Chemistry at the Owens College. Four years student in the Chemical Department of the Owens College. B.Sc. with Honours in Chemistry, Victoria University.

Harold B. Dixon.
P. J. Hartog.
Gilbert J. Fowler.
W. H. Perkin, jun.
Arthur Harden.
G. H. Bailey.

Bird, William Rowland,

73, Albion Street, New Swindon, Wilts.

Analytical Chemist. Six years' experience in Practical Analytical work at Great Western Railway Company's Laboratory, Swindon. Now Chief Assistant at the same Laboratory, and Teacher of Inorganic Chemistry for the Swindon and North Wilts Technical Education Committee.

F. W. Harris.
J. Jas. Morgan.
H. J. Phillips.
J. H. B. Jenkins.
L. Archbutt.

Bose, Chuni Lal,

24, Mohendro Bose's Lane, Calcutta.

Assistant Chemical Examiner to Government, and Assistant Professor of Chemistry, Medical College, Calcutta. Is a Bachelor of Medicine of the Calcutta University; has been Assistant Chemical Examiner to Government, and Assistant Professor of Chemistry, Medical College, Calcutta, since May, 1888. Made the following contributions to Medical and Chemical Science:—1. "On the Deposit of Yellow Arsenic in the Heart in a case of Arsenical Poisoning," *Indian Medical Gazette*, October, 1872. 2. "On the Analysis of certain samples of Tinned Meat," *Chemical News*, 20th and 27th June, 1890. 3. "On the presence of Cholesterol in the Roots of *Hygrophila spinosa*," *Pharmaceutical Journal*, June 25th, 1892. 4. "On certain Reactions of an Alkaloid contained in the Roots of *Randolfia serpentina*, Beuth," *Pharmaceutical Journal*, August 6th, 1892. 5. "On False 'Bikhma,'" *Pharmaceutical Journal*, October 15th, 1892.

C. J. H. Warden.
Tarapusauna Roy.
Preo Loll Dey.
Ramchandra Dutta.
Kanny Loll Dey.
Charles Henry Wood.

Boul, William Good, M.A.,

Churcher's College, Petersfield.

Science Master. Science Master, Churcher's College, Petersfield; Lecturer in Chemistry for the Hants County Council, Petersfield (Centre); Senior Moderator, Trinity College, Dublin.

J. Emerson Reynolds.
Vaughan Cornish.
Arthur E. Barclay.
Augustus E. Dixon.
William Jago.
Fred. W. Warrick.

Burgess, Herbert Edward,

144, Warwick Street, Eccleston Square, S.W.

Student of Chemistry. Studied for a year and a half in the Laboratory of Professor Clowes, Nottingham. Have been a student since October, 1892, in the Chemical Laboratory, King's College, London. Fellow of the Society of Chemical Industry.

John M. Thomson.
C. A. Mitchell.
R. Lloyd Whiteley.
Frank Clowes.
Stephen N. Wellington.
J. B. Coleman.

Cain, John Cannell,

Stubbins Villa, Stubbins, near Manchester.

Research Student at the Owens College. B.Sc. (Vict.). Honours School of Chemistry, 1892. D.Sc. (Tübingen), 1893. Late Dalton Chemical Scholar and holder of 1851 Exhibition Scholarship in the

Owens College, Manchester. Joint Author of (1) "Action of Acetic Acid on Phenylthiocarbimide," with J B. Cohen, *J. Chem. Soc.*, 1891; (2) "A Simple and Rapid Method of Quantitative Analysis," with G. H. Bailey, *J. Soc. Chem. Ind.*, 1891.

G. H. Bailey. Harold B. Dixon.
W. H. Perkin, jun. Arthur Harden.
Gilbert J. Fowler. P. J. Hartog.
Wm. A. Bone.

Chattaway, F. D.,

St. Bartholomew's Hospital, E.C.

Demonstrator of Chemistry. D.Sc. London. Ph.D. Munich. B.A. Oxon. Has contributed papers to *Berichte*, in conjunction with Dr. Bamberger, "On Chrysene and Picene," and to *Trans. Chem. Soc.*, "On the Phenylnaphthalenes."

W. J. Russell. A. Vernon Harcourt.
Henry E. Armstrong. William A. Tilden.
Sidney Williamson.

Dains, Herbert Henry,

3, Cantonment, Vizianagram, Madras Presidency, India.

Lecturer on Chemistry and Analytical Chemist. Science Scholar at Yorkshire College. 3 years' training in Chemistry. 1½ years in Soap Works Laboratory. Present occupation, Lecturer on Chemistry and Analytical Chemist. Fellow of the Institute of Chemistry.

Arthur Smithells. Herbert Ingle.
J. Lewkowitsch. *C. F. Baker.*
J. B. Cohen.

Davies, Samuel Henry,

Dalton Hall, Manchester.

Demonstrator at Owens College. Bachelor of Science. Honours Chemistry, Victoria University. Demonstrator Yorks College, Leeds, 1891–92. Demonstrator Owens College, Manchester, 1892–93. Recently appointed Lecturer in Chemistry at the Battersea Polytechnic. Contributions to Chemical Literature: (1) "Zur Kenntniss der Alkyl und Acidyl Sulphide"; (2) "Ueber die Einwirkung von Salzsaurem Hydroxylamin auf Acetomesitylen," together with E. Festh, *Ber.*, 1891.

Harold B. Dixon. Arthur Harden.
W. H. Perkin, jun. Arthur H. Crossley.
P. J. Hartog.

Duncan, Dr. John,

St. Petersburg, Russia.

Privy Councillor, Chief of the Sanitary Police, St. Petersburg Member of the Chemical Society of St. Petersburg.

T. E. Thorpe. F. A. Abel. James Dewar.
Henry E. Armstrong. W. Palmer Wynne.

Dunne, Basil Leonard,

64, Lower Leeson Street, Dublin.

Teacher in Chemistry, lately Lecturer in Chemistry to the Teachers in training at the Christian Schools. Some time acted as Assistant in the Chemical Laboratory, Royal College of Science, Associate of the Royal College of Science, Dublin, in the Faculty of Manufactures. Associate of the Institute of Chemistry. B.A. of the Royal University of Ireland in Chemical and Geological Science.

W. N. Hartley. Hugh Ramage. Ernest Clark.
W. E. Adeney. Thos. A. Shegog.

Evershed, Frank,

Kenley, Surrey.

Analytical and Manufacturing Chemist. Chemist to Messrs. Brooke, Simpson, and Spiller, Ltd., Aniline Dye Manufacturers, Hackney Wick. Formerly Assistant to Dr. Frankland in the Water Analysis Laboratory, Science Schools, South Kensington.

R. Meldola.
R. J. Friswell.
A. J. Greenaway.
R. Warington.
A. G. Green.
Leonard T. Thorne.

Fawcett, Joseph Addey,

153, Malpas Road, Brockley, S.E.

Gentleman. Student of Chemistry. Certificated in "Inorganic Chemistry" and "Steam," Science and Art Department, and "Corn Milling," City and Guilds of London Institute. Inventor of flaked cereals for brewing purposes.

Walter J. Sykes.
J. Jackson.
Arthur R. Ling.
Bernard Dyer.
Bertram Blount.
H. Droop Richmond.
Sidney Harvey.
Otto Hehner.

Harrison, Edward Frank,

17, Bloomsbury Square, W.C.

Assistant Lecturer on Chemistry to the Pharmaceutical Society.

and Demonstrator in the Research Laboratory. Joint Author with Professor Dunstan of paper on "Isaconitine" (*J. Chem. Soc.*, 1893, 443).

Wyndham R. Dunstan. John Attfield. M. Carteighe.
Thos. S. Dymond. Henry G. Greenish.

FitzGerald, Henry Purefoy,

Wellington College, Berks.

Science Master at the above. B.A. of Oxford University (Keble College). 1st Class in Final Honour Schools in June, 1893, the subject taken being "Chemistry"; now Senior Master in Chemistry and Physics at Wellington College.

W. W. Fisher. V. H. Veley. J. E. Marsh.
Wm. Odling. John A. Gardner. John Watts.
D. H. Nagel. *John Conroy.* *P. Elford.*
A. Vernon Harcourt.

Gay, Ernest William,

14, St. Julian's Road, Kilburn, N.W.

Chemist. For the past seven years engaged in the study of Chemistry and Physics, both in the School of Mines, Camborne, Cornwall, and in the Laboratory under Dr. A. B. Griffiths, Ph.D., F.C.S., &c.

A. B. Griffiths. Harold Follows. Alexander Hay.
Lionel Cooper. *C. T. Kingzett.* *Thomas A. Pooley.*
E. C. Conrad. *P. A. Estcourt.* *H. J. Mousley.*

Grafton, Walter,

11, Grosvenor Road, Upton Park, Essex.

Gas Analyst and Assistant in a Gas Works. Analytical Chemist. Studied Theoretical and Practical Chemistry for three years at the Royal Polytechnic Institute. I have acted as Assistant for nearly two years to Mr. Greville Williams, F.R.S. Author of papers—"The Standard of Light" (*Journal of Gas Lighting*, 1891), "To Facilitate the Correction of the Volume of Gas at different Temperatures and under different Atmospheric Pressures, with Table" (*Journal of Gas Lighting*, 1893). For the last three years Chief Gas Analyst to the Beckton Station of the Gas Light and Coke Company. Special experience in the manufacture of Illuminating Gas and analysis of Coals.

W. C. Young. Greville Williams. Vivian B. Lewes.
W. J. Dibdin. R. Grimwood.

Hamilton, Robert,

5, Lake Street, Hunslet, Leeds.

Analytical Chemist. For 5 years Assistant to Wallace, Tatlock, and Clark, City Analysts, Glasgow. For 3 years Chemist at Glengarnock Iron and Steel Works (the first in Scotland to adopt the Basic Steel Process). For 5 years Chemist (during the last 4 years Chief Chemist) at the Leeds Steel Works Ltd.

Robert R. Tatlock. John Clark.
J. E. Stead. Harry W. Dixon.
Wm. McD. Mackey. *Horatio Ballantyne.*
F. W. Branson.

Hayward, Edward Stanley,

23, St. Thomas Street, Winchester, Hants.

Science Master. Formerly Chemistry Master of Essingwood Grammar School, York. Chemistry Master at the Grammar School, Crediton, Devon.

W. B. Bottomley. John Percival.
A. Hutchinson. Thomas H. Easterfield.
Henry J. Monson.

Heap, Isaac Henry, M.P.S.,

Fern Bank, Aynsley Road, Stoke-on-Trent.

Pharmaceutical Chemist. Major Examination of Pharmaceutical Society. Desirous of receiving the Society's Journal, with a view of keeping up a knowledge of Theoretical and Manufacturing Chemistry.

M. Carteighe. John Attfield. John C. Thresh.
Michael Conroy. *Edward Davies.*

Hills, Edmond Herbert,

Darland House, Chatham.

Captain Royal Engineers. Instructor of Chemistry and Photography at the School of Military Engineering, Chatham.

T. E. Thorpe. W. de W. Abney.
Chapman Jones. W. Palmer Wynne.
William Tate.

Holmes, John Winder,

28, Crooms Hill, Greenwich.

Chemist in connection with Brewery. $2\frac{1}{2}$ years' Chemical work in King's College Laboratory and 3 months in Mr. Laurence Briant's Laboratory, 24, High Holborn.

R. Meldola. John M. Thomson.
G. Stillingfleet Johnson. Herbert Jackson.
Arthur J. Starey.

Hornby, R., B.A.,

Long Preston, Leeds.

Science Master. Hastings Exhibitioner in Chemistry and Physics, Queen's College, Oxford. Burdett-Coutts (University) Scholar, 1st Class Honours in Chemistry and Geology. Senior Science Master, the High School, Newcastle (Staffordshire).

Wm. Odling. V. H. Veley. John Watts.
W. W. Fisher. H. G. Madan. R. Stockdale.

Hughes, Frank,

27, Fairfield Road, Chelmsford.

Demonstrator in Chemistry, Essex C.C. Technical Instruction Committee. Studied Chemistry at Finsbury Technical College, three years; obtained the College certificate. Joint Author of following papers, published in *Trans. Chem. Soc.:* "The Formation of Indene Derivatives from Dibrom-α-naphthol," **57**, 393; "A Third Naphthaquinone," **57**, 631; "Note on the Action of Nitric acid on Dibrom-α-naphthol," **57**, 808; "Notes on the Azo-derivatives of β-Naphthylamine," 1891, 372, by Raphael Meldola, F.R.S., and Frank Hughes. Appointed for one year to carry on chemical investigations at Laboratory of Marine Biological Association. Now Demonstrator at Central County Laboratory of the Essex C.C.

R. Meldola. Thos. Tyrer.
Thomas S. Dymond. Harold G. Colman.
John C. Thresh.

Hutchinson, Alfred,

The Leys, Cambridge.

Senior Science Master, The Leys School. Scholar of Trinity College, Cambridge. 1st Class Natural Sciences Tripos, Parts I and II.

G. D. Liveing. T. H. Easterfield. Alexander Scott.
J. T. Hewitt. H. J. H. Fenton.

Jackson, David Hamilton, M.A., B.Sc.,

Royal College of Science, South Kensington.

1851 Commission Exhibitioner from the University of New Zealand. Has studied Chemistry at the Auckland College, New Zealand, under Professor F. D. Brown, and at the University of Melbourne, under Professor Orme Masson. Now engaged in Research Work at the Royal College of Science.

T. E. Thorpe. J. W. Rodger. W. Palmer Wynne.
A. E. Tutton. *Chapman Jones.*

Jardine, Walter,

86, Victoria Place, Perth.

Teacher. Graduated M.A. Glasgow University, 1890. Studied Chemistry under Dr. Andrew Thomson, 1890–93. Obtained Honours (Theoretical and Practical) in Science and Art Department Examination, 1893. At present teaching Chemistry at Sharp's Institute and under Perth County Council.

Andrew Thomson. David Ferrier.
T. S. Murray. John Alexander.
F. R. Japp. *Percy F. Frankland.*
Fred. J. Hambly. *Jas. R. Appleyard.*

Jennison, Francis Herbert,

Moscow, Russia (address c/o A. Illingworth, Moscow).

Chemist and Dyer to the "First Moscow Company's Dyeworks." As a student, I spent from October, 1886, to January, 1892, working in the Laboratories (Chemical and Dyeing) of the Yorkshire College, during which I took the complete course of Dyeing and Chemistry. In 1889 was elected an Associate of the Institute of Chemistry, and since 1892 have been at work on machine dyeing.

Arthur Smithells. J. J. Hummel. Herbert Ingle.
C. F. Baker. *J. B. Cohen.*

Jenks, Robert Leonard,

68, Victoria Road, Clapham, S.W.

Honorary Demonstrator in Chemistry at the City and Guilds of London Central Institution. Student in Chemistry at Central Institution, 1889–92. Associate of the same, 1892.

Henry E. Armstrong. F. Stanley Kipping.
Gerald T. Moody. W. J. Pope.
Chas. Mills. W. Palmer Wynne.

Lapworth, A.,

13, Duchess Road, Birmingham.

Student in Chemistry. B.Sc. (Honours) of University of London. Four years Science Student at Mason College, Birmingham, and holder of 1851 Exhibition Scholarship (in Chemistry).

William A. Tilden. W. W. J. Nicol.
Sidney Williamson. Martin O. Forster.
Henry E. Armstrong.

Leonard, Norman,

2a, Lorn Road, Brixton, S.W.

Analytical Chemist. Bachelor of Science and University Scholar in Chemistry of London University. Associate of the Institute of

Chemistry. For five years a student at University College, Bristol, and now Senior Assistant to Dr. Thos. Stevenson, of Guy's Hospital.

Thos. Stevenson. Charles E. Groves. William Ramsay.
Sydney Young. Arthur Richardson. R. Bodmer.

Lucas, E. W.,

225, Oxford Street.

Director of the Laboratory of Messrs. John Bell and Co. Studied Chemistry and Practical Chemistry in the School of the Pharmaceutical Society during one Session. Passed the Major Examination of above Society in 1888. For three years Assistant Government Analyst and Apothecary in the Colony of Hong Kong, where I conducted a considerable portion of the general analytical and toxicological work. Have published following paper:—"Note on a Method of Measuring Micro-organisms in Air" (*Pharm. Journal*); also a Report on the Water Supply of the City of Victoria, Hong Kong, published by the Government for information of public.

Wyndham R. Dunstan. M. Carteighe. John Attfield.
Joseph Ince. Walter Hills.

Luty, Arthur,

30, Bryn-y-mor Terrace, Swansea.

Analytical Chemist and Metallurgist. Four years general Analytical work, Foods, Metal, &c., at the Technical Institute, Swansea, under Dr. Moorgan; and in my second year as Experimental and General Chemist, at Messrs. C. Lambert and Co.'s, Port Tennant Copper Works, Electro Department.

W. Morgan. W. Terrill. Rhys Charles.
Frank B. Last. *Otto Hehner.*

Macdonald, A. H.,

The Green, Marlborough, Wilts.

Intends to teach Chemistry. Late Exhibitioner (in Chemistry) of Keble College, Oxford. Second class in Honour School of Chemistry 1893.

Wm. Odling. W. W. Fisher. V. H. Veley.
J. A. Gardner. J. E. Marsh. John Watts.

Melland, Godfrey,

Victoria Park, Manchester.

Research Student in Owens College. Four years student in the Owens College Chemical Laboratories. B.Sc. with Honours in

Chemistry, Victoria University. Two and a-half years student in the School of Mines; Associate in Metallurgy of the R.S.M.

Harold B. Dixon. Arthur Harden.
W. H. Perkin, jun. Arthur W. Crossley.
P. J. Hartog.

Murray, J. M., B.Sc.,

Highfield, Holmes Chapel, Cheshire.

Research Student in Chemistry. Three years in Chemical Laboratories of Owens College. B.Sc., with Honours in Chemistry, at Victoria University. Researching with Professor Perkin.

Harold B. Dixon. G. H. Bailey.
P. J. Hartog. W. H. Joseland.
Gilbert J. Fowler. W. H. Perkin, jun.
J. B. Cohen.

Pearson, William Henry,

4, Bryn Villas, Blaina, Mon.

Analytical Chemist. Assistant for five years to Mr. J. E. Stead, F.C.S., F.I.C., of Messrs. Pattinson and Stead, Analytical Chemists and Assayers, 5, Zetland Road, Middlesbro'. At present Analyst to the Pyle and Blaina Works, Limited, at Blaina, Mon., and Pyle, Glam., manufacturers of Ferromanganese, Spiegeleisen, &c.

J. E. Stead. H. Frankland. C. H. Ridsdale.
Richard Dormer. *John Pattinson.*

Peden, John, jun.,

Blair Terrace, Greenock.

Analytical Chemist. I was with the Public Analysts of this town as Assistant for about five years, and for the past four and a half years have carried on business on my own account as an Analyst, at 11, Duff Street, Greenock.

A. Humboldt Sexton. R. R. Tatlock.
Horatio Ballantyne. Angus Smith.
T. L. Patterson.

Paterson, David,

Lea Bank, Roslin, N.B.

Colour Chemist in Carpet Works. Studied Chemistry with Prof. Perkin at Heriot Watt College, Edinburgh. Contributed papers on "Capillarity of Aniline Colours," and the "Use of Antimony Trifluoride Ammonium Sulphate Double Salt as a Mordant" to

Journal of Dyers and Colourists. Colour Chemist in Carpet Works.

W. H. Perkin, jun. Stevenson Macadam.
Robert Irvine. James Stenhouse.
John Hunter. *F. Stanley Kipping.*

Paulusz, Richard,
Colombo.

Apothecary, General Hospital, Colombo. Lecturer on Practical Pharmacy at the Ceylon Medical College; Assistant to the Public Analyst, Ceylon; attended three Courses of Lectures (on Chemistry, Inorganic and Organic) in the Ceylon Medical College; and passed the final Examination of the Junior Branch.

M. Cochran. E. Roberts. F. C. H. Clarke.
Wm. R. Burnett. *Kanny Lall Dey.* *Preo Lall Dey.*

Pollok, J. Holmes,
37, Athole Gardens, Glasgow.

Consulting Chemist; B.Sc. Glasgow; Author of Paper on "Saline Solutions" (Roy. Soc. Edin.), and on "Refractory Gold Ores" (Soc. Chem. Ind.), and several Patents for treatment of Gold Ore.

John Ferguson. J. T. Bottomley.
G. G. Henderson. A. Humboldt Sexton.
C. M. Aikman.

Quinn, J. Cardwell,
Woodcroft, Gateacre, near Liverpool.

Chemist and Assayer. Bachelor of Science, with Honours (Victoria); Associate of the Institute of Chemistry; Student of Chemistry for the past 7 years; at present Experimental Chemist to the Patent Films Syndicate, Limited.

Michael Conroy. Charles A. Kohn.
J. Campbell Brown. H. B. Stocks.
Thomas Turner.

Robertson, A. B.,
Dungoyne, Bearsden, by Glasgow.

Lecturer on Chemistry in the Coatbridge Technical School and Mining College. Over 6 years Lecturer on Chemistry in Glasgow Academy, Glasgow Western Medical School, and Coatbridge Technical School and Mining College, and to the Faculty of Physicians and Surgeons of Glasgow and Edinburgh; Author of "Researches on Ethyl and Methyl Alcohols, Quantitative Electrolysis," &c., &c.;

Author of Analytical Tables, &c.; ready for publication, book on Quantitative Analysis.

R. R. Tatlock. A. Humboldt Sexton.
James Robson. Thos. Gray.
G. G. Henderson.

Ross, Arthur,

1, Glengall Road, Old Kent Road, S.E.

Analytical Chemist. I have been through the Chemical Course at Finsbury Technical College for 3 years during the day, and 3 years evening course. The Institute of Chemistry have this month accepted my application to be examined by them; and I have been engaged in examining Waters and Water Deposits for the last 2 years.

R. Meldola. T. L. Phipson.
A. Hall. Thomas J. Underhill.
Charles Rumble.

Rouillard, Richard A.,

5, Dundonald Road. Wimbledon, and Mauritius.

Analytical Chemist. Was formerly a Student of the Royal College of Mauritius; Matriculated in the University of London (1891); have been Assistant to Mr. Leon Ehrmann, Analytical Chemist, in Mauritius, and have also for some time been specially engaged in the study of Agricultural Chemistry.

John A. R. Newlands. John Wrightson.
Bernard Dyer. B. E. R. Newlands.
Chapman Jones. John Hughes.
F. A. Manning.

Rowntree, Walter Smithson,

53, Grosvenor Road, London, S.W.

Research Assistant in Physiological Chemistry to Dr. Pavy, F.R.S. Studied Chemistry at Owens College, Manchester; at the Royal College of Science, South Kensington; and for a short time in the laboratories at Heidelberg. Four years' subsequent work, in conjunction with Dr. Pavy, F.R.S., in the Conjoint Laboratories of the Royal Colleges of Physicians and Surgeons, upon the Chemistry of the Carbohydrates. Results in part brought before the Royal Society in June last, and shortly to be published in full.

Chapman Jones. A. E. Tutton.
William Tate. Harold Gripper.
Gilbert J. Fowler. *W. Palmer Wynne.*

Smith, Charles Henry,

The Bungalow, Nassau, Bahamas, W.I.

Principal, the Bahamas Training Institute for Teachers; Curator of the Laboratory in connection with the Borough Road College for Schoolmasters, and afterwards Junior Chemistry Tutor of same College, and Lecturer. Assisted at the Toynbee Hall East London University Extension Movement, more particularly in the popularising of Chemistry before the opening of Science Classes at the People's Palace; done considerable quantitative work at the Royal College of Science, under Dr. Japp, now Professor at St. Andrews, being placed in the 1st Class of Chemistry Teachers at the Summer Course. Have ultimate hopes of founding some kind of Chemical Instruction in West Indies, where affiliation to some such recognised Society is of greater import than previous work in Chemistry, and Kensington results, seeing I have no Science Degree. Further, was working for London B.Sc. when my departure broke up my examinations.

J. Howard. R. L. Taylor. H. Entwistle.
J. H. Gladstone. *William Ping.*

Spillan, Harry Ernest, A.C.P., &c.,

5, Belitha Villas, Barnsbury Park.

Science Lecturer and Demonstrator. For many years Lecturer and Demonstrator at Islington, Tottenham, Walworth, Hackney, &c Holder of 14 Science Certificates; South Kensington, Graduate, &c &c. Author Scientific Articles.

W. J. Cousins. G. Russell Beardmore.
Edward C. Cyril Baly. *G. T. Holloway.*
Henry Bassett.

Tanner, Alfred E.,

2, Bruce Grove, Tottenham.

Pharmaceutical Chemist. Examiner in Practical Chemistry at the Pharmaceutical Society of Great Britain. Lecturer on Pharmacy and Materia Medica, Westminster Hospital Medical School, &c., &c.

A. Dupré. M. Carteighe.
Thos. P. Blunt. H. Wilson Hake.
W. J. Dibdin. Wyndham R. Dunstan.

Trench, George,

Standard House, Faversham.

Manager of Explosive Works. Member Society of Arts and

Chemical Industry. Twenty years' experience of manufacture of Explosives and Acids, &c.

P. Gerald Sanford.
Rudolph Messel.
William Newton.
Henry de Mosenthal.
R. T. Marshall.
W. H. Cannon.
Arnold Philip.

Williams, William Lloyd,

Erbistock Villa, 10, Miskin Road, Dartford.

Chemist and Assistant-Manager, 1890–93, to Messrs. Burroughs, Wellcome & Co., Phœnix Mills, Dartford. Fellow Institute Chemistry, 1892 (Associate, 1889). Silver Medallist, Pharmaceutical Society, Session 1882–83 (Chemistry, Botany, and Materia Medica). Pharmaceutical Chemist. Worker in Research Laboratory, Pharmaceutical Society, 1888–89. Joint Author with Professor Dunstan, "The Metameric Amyl Nitrites," *Pharm. J.*, 1888. Laboratory Manager to John Moss & Co., Galen Works, New Cross, S.E., October, 1889—December, 1890.

M. Carteighe.
John Attfield.
Thomas Tyrer.
Wyndham R. Dunstan.
John Moss.
A. Searl.

Wingate, Hamilton More, B.Sc.,

3, Buckingham Street, Glasgow, W.

Late Junior Assistant, Chemical Department, University of Glasgow. Analytical and Metallurgical Chemist, Melbourne, Australia.

Joshua Buchanan.
C. M. Aikman.
Thomas Gray.
G. G. Henderson.
Hugh Brown Collins.
Bernard Dyer.

Young, Meredith, M.B., C.M. (Edin.),

Brighouse, Yorks.

Medical Officer of Health. As Medical Officer of Health to the Borough of Brighouse, and to the Halifax Rural Sanitary Authority engaged in Chemical Analysis, &c., as applied to Hygiene. Formerly student of Sanitary Chemistry at the Yorkshire College, Leeds.

Arthur Smithells.
Julius B. Cohen.
Herbert Ingle.
James Robt. Kaye.
E. Norman Langham.

The following Candidates are recommended by the Council for ballot under Bye-law I (para. 3):—

Harvey, W. Pellew,

Golden, British Columbia.

Assayer and Analytical Chemist. 1875–79, Student of Theoretical and Practical Chemistry with J. H. Collins and A. K. Barnett, F.G.S.; 1879–82, learning Assaying and Analytical Work with Messrs. Vivian & Sons, Truro, Cornwall; 1882–84, on the staff of Messrs. Vivian & Sons, Hafod Copper Works, Swansea; 1885–90, managing the Laboratory of Messrs. John F. Penrose & Sims, Redruth; 1890–91, Chemist to Golden Mining and Smelting Company, Golden, British Columbia. Left to better my position in 1891, and have since practised privately as an Assayer and Analytical Chemist in Golden, British Columbia, during which period I have acted as Chemist to Mr. Arthur Forest, cyanide process here, and in 1892 was selected by British Columbia Government to make all assays and analyses on specimens sent from the Province to World's Fair, Chicago.

P. Gerald Sanford. John J. Beringer.
Jos. Lainson Wills. George Attwood.

Lee, Clifford Walker,

Oaklands, Dewsbury, Yorkshire.

Chemist to the Atacama Mineral Company, Taltac, Chili. Three years Chemical Student and Laboratory Assistant, Grammar School, Batley, Yorks. Two years Chemical Student evening classes, Polytechnic, Regent Street, and Finsbury Technical College, London. Four years Assistant in Assay Offices and Laboratories of Messrs. Johnson & Sons, 23, Cross Street, London, E.C. Three years Chemist to the Atacama Mineral Company, Taltac, Chili.

H. Y. Lorain.

Jaubert, George F., Ph.D.,

Anilin Fabrik, Ludwsgshafen am Rh.

Chemist in Head Laboratory of the Badische Anilin und Soda Fabrik. Studied Chemistry for five years with Professor Graebe, two years as Assistant. Published paper on "1 : 1′-Naphthalic Acid and its Derivatives" (see Abstract, *Chem. Soc. Journ*, **64**, 477). A continuation of this work will shortly be published, with Professor Graebe, in the *Annalen der Chemie.*

Ernest Ehrhardt.

HARRISON AND SONS, PRINTERS IN ORDINARY TO HER MAJESTY, ST. MARTIN'S LANE.

357.76	2
365.31	4
377.50	8
385.63	16
392.86	32
397.82	6

Issued 10/2/1894

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

No. 133. Session 1893-94.

February 1st, 1894. Dr. Armstrong, President, in the Chair.

Certificates were read for the first time in favour of Messrs. F. E. Allhusen, Jesus College, Cambridge; Charles Henry Ashdown, Belmont, St. Albans, Herts; Harry Bowes, 9, Union Terrace, Chatham Hill; Thomas Chambers, Dudley House, Coatbridge, N.B.; Edwin Terry, 41, Nightingale Lane, Balham, S.W.; Arthur Robert Golden, B.A., 17, Trinity Street, Norwich; William Albert Knight, Sexey's Trade School, Bruton, Somerset; James Mansell, B.A., 49, Upper Tichborne Street; Charles McMullan, Holywood, co. Down, Ireland; Frederick Wallace Stoddart, Grafton Lodge, Sneyd Park, Bristol; Henry L. Wheeler, 1812, Prairie, Chicago, U.S.A.

Of the following papers those marked * were read:—

*108. "Note on the liberation of chlorine during the heating of a mixture of potassic chlorate and manganic peroxide." By Herbert McLeod, F.R.S.

In 1889 the author suggested an explanation of the catalytic action which takes place when an "oxygen mixture" is heated, an essential feature in the explanation being the evolution of a small quantity of chlorine; a few months later O. Brunck published in the *Berichte* a statement that the gas evolved together with oxygen is not chlorine but ozone.

The author has made several experiments to endeavour to solve the question. A mixture of potassic chlorate and manganic peroxide was heated in a test tube by means of the vapour of boiling mercury, and the evolved gas was passed through a U-tube filled with small glass beads to remove any potassic chloride carried over mechanically, and then through another U-tube containing an ammoniacal solution of argentic nitrate. On subsequently acidifying the solution with nitric acid, argentic chloride was precipitated. The quantity of chlorine calculated from the amount of the precipitate was not dissimilar from the quantity given in the previous paper.

On extracting the residue with water, filtering and adding litmus solution, the liquid was found to be slightly alkaline. The alkalinity was determined by means of a centinormal solution of oxalic acid, and was found to correspond fairly well with the quantity of chlorine in the argentic chloride.

One test only was made for the presence of ozone in the gas. The beads in the first U-tube were moistened with a strong solution of potassic iodide, the mixture was heated as before in mercury vapour and no coloration was seen on acidifying the potassic iodide solution, indicating that under the conditions of the experiment, ozone was not produced.

Discussion.

Professor Dunstan remarked that the odour of the gas evolved from the mixture was more like an oxide of chlorine than chlorine itself. He enquired whether Professor McLeod had ascertained whether a mixture of potassium chloride and manganic oxide furnished chlorine when heated in mercury vapour. If so, then not only the production of chlorine, but also of permanganate and alkali, from the chlorate was susceptible of another explanation.

Professor McLeod stated that he had not hitherto closely investigated this question.

109. "The examination of some recent freezing point determinations."
By S. U. Pickering, F.R.S.

Mr. Harry Jones has recently made a number of freezing point determinations with weak solutions for which a very high degree of accuracy is claimed, and which have led him to the unexpected conclusion that non-electrolytes exhibit abnormally large depressions of a character similar to those exhibited by electrolytes. This must necessarily invalidate all the conclusions drawn from the abnormal depressions given by the latter. On examining his results, it was found that they all formed figures of a curvilinear character, even in cases where the author's previous determinations showed comparative regularity and constancy. It was considered probable that this peculiarity of Mr. Jones's results might be due to some error in the calibration of his instrument, and this was borne out by the fact that the differences between his and the author's determinations were in every case—there being eight cases available for the comparison—of the same sign at the same temperatures, these differences forming, when plotted, a wavy curve. As the author used two different thermometers in his determinations, the error can scarcely be attributed to his instruments. A further comparison with one series of results by Raoult and six series by Loomis gave confirmatory evidence of the existence of an error of this wavy character in Mr. Jones's results; so also did a comparison of his values with those calculated from Kohlrausch's conductivity determination.

The total error in Mr. Jones's results amounts to at least 0·01°, and is quite sufficient to account for the abnormal results which he has obtained with non-electrolytes, and for the wavy character of his results generally.

His results give clear indications of the existence of changes of curvature in many cases, which would not appear to be negatived by the error of his measurements. In the case of sulphuric acid the peculiar character of the figure which his results form confirms in a striking manner the author's previous results (Trans., 1890, 357), since they show breaks at the same points as the author's did, and the two figures are practically identical when Mr. Jones's results are corrected according to a mean deduced from the comparison with the various authorities mentioned.

110. "Salts of dehydracetic acid." By J. Norman Collie, Ph.D., and H. R. Le Sueur, B.Sc.

The reason for preparing these salts was, if possible, to obtain additional evidence bearing on the constitution of dehydracetic acid. During many years this substance was considered to be a true acid, that is to say, it was supposed to contain a carboxyl group. Owing, however, to one fact first noticed by Ostwald, namely. the extremely low dissociation constant, this idea was abandoned, and Feist first suggested that the substance was a lactone.

Naturally, therefore, if dehydracetic acid were a lactone of the formula $C_8H_8O_4$, its salts should possess the general formula $C_8H_9O_5M$; and the examination of these compounds ought to at once decide the question. The salts prepared are the following:—Sodium salt, $C_8H_9O_5Na \cdot H_2O$. Potassium salt, $C_5H_9O_5K \cdot H_2O$. Magnesium salt, $(C_8H_9O_5)_2Mg \cdot \frac{1}{2}H_2O$. Calcium salt, $(C_8H_7O_4)Ca \cdot H_2O$. Barium salt, $(C_8H_9O_5)_2Ba$. Zinc salt, $(C_8H_9O_5)_2Zn$. Cadmium salt, $(C_8H_9O_5)_2Cd$. Cobalt salt, $(C_8H_9O_5)_2Cd \cdot \frac{1}{2}H_2O$. Manganese salt, $(C_8H_9O_5)_2Mn$. Copper salt, $(C_8H_7O_4)_2Cu$. Silver salt, $C_8H_9O_5Ag$. Lead salt, $(C_8H_9O_5)_2Pb$. Ethylic salt, $C_8H_7O_4C_2H_5$.

Nearly all of these were perfectly stable at 100°, but all of them (with the exception of the copper salt and the ethylic salt, which did not lose water) when heated to as high as 145°, gave off water and left, without exception, salts of the formula $C_8H_7O_4M$.

The examination of the salts, therefore, has not enabled the authors to decide the question ; for, although all the salts lose water when heated, leaving compounds which are derivatives of the substance $C_8H_8O_4$, still owing to the high temperature necessary in some cases to effect this change, the water may be other than that of crystallisation.

111. "A new method of producing carbon tetrabromide." By J. Norman Collie, Ph.D.

Whilst working with a yellow naphthalene compound which he had obtained from dehydracetic acid (Trans., 1893, 329), the author noticed that when it was heated with a strong solution of sodium hypobromite, it yielded a volatile, solid compound. This substance was found to be tetrabromide of carbon and was formed to the extent of about 2—3 grams from 10 grams of the naphthalene derivative.

On experimenting with other compounds, the author finds that this interaction is very general and that widely diverse carbon derivatives all yield tetrabromide of carbon when warmed with strong solution of sodium hypobromite.

Amongst others may be mentioned alcohol, glycol, glycerol, mannitol, malic acid, citric acid, maleic and fumaric acids, sugars, starches, celluloses, &c. Amongst benzene derivatives, the phenols, especially carbolic acid, orcinol, resorcinol, α- and β-naphthol, alizarin, &c. ; oxypyridine derivatives give it easily, also a large number of the alkaloids. It is evidently a very general interaction and depends to a large extent on the powerful oxidising or breaking down power of the alkaline solution of sodium hypobromite. Bromoform is probably formed prior to the final stage which the author is inclined to believe involves the conversion of bromoform into carbon tetrabromide.

112. "Metallic derivatives of acetylene. Mercuric acetylide." By M. Travers, B.Sc., and R. T. Plimpton, Ph.D.

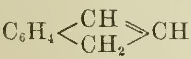
Berthelot (*Ann. Chim. Phys.*, [4], 9, 386), by passing acetylene through a solution of mercuric iodide in potassium iodide made alkaline with ammonia, obtained an explosive mercury acetylide, of which, however, he seems to have made no analysis. The authors have prepared this substance in various ways and studied its composition and properties. They have prepared it by the action of acetylene, 1, on freshly precipitated mercuric oxide ; 2, on solutions of mercuric cyanide mixed with ammonia, or, better, with ammonia and cupric sulphate or zinc chloride; 3, on solutions of mercuric acetate or sulphate with ammonia, when a part only of the mercury is precipitated; 4, on mercuric oxide dissolved by the aid of ammonia and ammonic carbonate. The latter method is the most convenient. The heavy, white powder which separates is well washed and dried at 100°. Analysis gave as the mean of four determinations: mercury, 87·1; carbon, 10·1 and 10·3. Calculated for $3C_2HgH_2O$: mercury, 87; carbon, 10·4 per cent. The substance could not be obtained free from water even after long drying at 100°. Mercuric acetylide belongs to the same class of bodies as the silver and copper acetylides; it is explosive, yields part of its carbon as acetylene when warmed with chlorhydric acid and part as aldehyde, and yields the compound C_2I_2 and eventually C_2I_4 when acted on by iodine dissolved in potassium iodide. It differs altogether from the substance obtained from solutions of mercuric acetate described in a previous note (Proc., 1892, 109), and which is non-explosive and in other respects resembles the allyene derivatives obtained by Katscheroff from solutions of mercuric chloride and acetate (*Ber.*, **17**, 13). Mercuric acetylide detonates violently when suddenly heated or struck sharply; it can, however, be handled with safety even when dry.

Dr. E. H. Keiser, who had apparently overlooked Berthelot's description of the substance and the note published in the Proceedings by one of the authors, has recently (*Amer. Chem. J.*, November, 1893) obtained the same substance, and attributes to it the formula C_2Hg: the authors have not been able to obtain either this or the silver compound free from water.

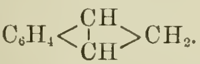
113. "Synthesis of indene, hydrindene and some of their derivatives."

By W. H. Perkin, junr., F.R.S., and E. Révay, Ph.D.

It is shown that when the barium salt of the hydrindenecarboxylic acid prepared by v. Baeyer and W. H. Perkin, junr., is heated, either alone or with sodium methoxide, it yields indene and not hydrindene. The indene thus obtained has a somewhat lower density but somewhat higher refractive and magnetic rotatory power than the indene separated from coal tar, although they are not chemically distinguishable. The authors incline to the view that the two products are isomeric, and that they perhaps correspond to the two formulæ



$$C_6H_4\!<\!\begin{matrix}CH\\CH_2\end{matrix}\!\gg CH$$



$$C_6H_4\!<\!\begin{matrix}CH\\|\\CH\end{matrix}\!>CH_2.$$

The action of bromine on hydrindenecarboxylic acid, and a number of ketones and their derivatives prepared from this acid, are described.

ADDITIONS TO THE LIBRARY.

I. *Donations.*

Quantitative Chemical Analysis, by F. Clowes and J. B. Coleman. 2nd edit. London 1894. From the Authors.

Californian State Mining Bureau. Eleventh Report of the State Mineralogist; two years ending September 15th, 1892. Sacramento 1893. From the Bureau.

II. *By Purchase.*

A Manual of Dyeing, by E. Knecht, C. Rawson and R. Lowenthal. London 1893.

A Text-Book of the Physiological Chemistry of the Animal Body, by A. Ganyer. London 1894.

A Treatise on Hygiene and Public Health, by T. Stevenson and S. F. Murphy. Vols. I and II. London 1893.

On the Chemistry of the Blood and other Scientific Papers, by the late L. C. Wooldridge, M.D., arranged by V. Horsley and E. Starling. London 1893.

At the next meeting, on February 15th, there will be a ballot for the election of Fellows, and the following papers will be read:—

"The analytical determination of available 'mineral' plant food in soils. (Illustrated by examination of the permanent barley soils of Hoos Field, Rothamsted.)" By Bernard Dyer, D.Sc.

"The aërial oxidation of turpentine and essential oils." By C. T. Kingzett.

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PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

No. 134. Session 1893-94.

February 15th, 1894. Dr. Armstrong, President, in the Chair.

Certificates were read for the first time in favour of Messrs. Samuel Bernard Asher-Aron, P.O. Box 1021, Johannesburg; Joseph Beynon Ashcroft, 96, Warner Street, Derby; Oswald Ernest W. Hewitt, 116, Burnt Ash Hill, Lee, S.E.; Charles T. W. Hirsch, Fiji Islands; Edwin James Jackman, 152, Upton Lane, Forest Gate E.; Alexander Mitchell Kellas, 24, Cecil Park, Crouch Hill, N.; John Abraham Kelly, Hyderabad, Deccan; Thomas John Roberts, 31, North Road, St. Helens, Lancashire.

The following were elected Fellows of the Society:—William Edward Bamber, William Rowland Bird, Chuni Lal Bose, William Good Boul, M.A., Herbert Edward Burgess, John Cannell Cain, F. D. Chattaway, Herbert Henry Dains, Samuel Henry Davies, Dr. John Duncan, Basil Leonard Dunne, Frank Evershed, Joseph Addey Fawcett, Henry Purefoy Fitzgerald, Walter Grafton, Robert Hamilton, Edward Frank Harrison, W. Pellew Harvey, Edward Stanley Hayward, Edmond Herbert Hills, John Winder Holmes, R. Hornby, B.A., Frank Hughes, Alfred Hutchinson, David Hamilton Jackson, M.A., B.Sc., Walter Jardine, George F. Jaubert, Ph.D., Francis Herbert Jennison, Robert Leonard Jenks, A. Lapworth, Clifford Walker Lee, Norman Leonard, E. W. Lucas, Arthur Luty, A. H. Macdonald, Godfrey Melland, J. M. Murray, B.Sc., David Paterson, Richard Paulusz, William Henry Pearson, John Peden, Jun., J. Holmes Pollok, J. Cardwell Quinn, A. B. Robertson, Arthur Ross, Richard A. Rouillard, Walter Smithson Rowntree, Charles Henry Smith, Alfred E. Tanner, George Trench, William Lloyd Williams, Hamilton More Wingate, B.Sc., Meredith Young, M.B., C.M. (Edin.).

It was announced that the following changes in the Council List were proposed by the Council:—

As *Vice-Presidents:* Mr. Horace T. Brown and Mr. Ludwig Mond *vice* Mr. J. Pattinson and Professor Tilden.

As *Members of Council:* Mr. A. G. Green, Dr. Kipping, Dr. Stevenson and Professor Sydney Young, *vice* Dr. Collie, Mr. L. Fletcher, Mr. M. M. P. Muir, and Mr. F. J. M. Page.

Mr. E. J. Bevan, Dr. Lawson and Mr. E. W. Voelcker were appointed by the meeting to audit the Treasurer's accounts.

Of the following papers that marked * was read:—

*114. "The analytical determination of probably available 'mineral' plant food in soils." By Bernard Dyer, D.Sc.

The paper contains a short notice of the principal papers hitherto published on this subject, and an account of a series of preliminary experiments made by the author in endeavouring to decide what was the most useful solvent for extracting "available" (as distinguished from "total") mineral constituents of plant food from soil.

These experiments led him to seek to determine the average acidity of the root sap which plants have at their disposal as a natural solvent for such constituents. Determinations involved in the examination of about 100 plants, made in order to arrive at this, are recorded in detail.

As these determinations appeared to indicate the suitability as an analytical soil-solvent of a 1 per cent. solution of citric acid—the same solution that, on grounds quite differently approached, had been suggested by Tollens and Stutzer as an agent for like purposes in testing manures—the author decided to try the effect of the solution on soils of known history and recorded fertility.

For the purposes of this trial, 22 separate plots of the experimental barley field at Rothamsted were sampled, with the kind permission and assistance of Sir John Lawes and Sir J. Henry Gilbert, and the samples were all subjected to separate investigation. A detailed account of this work is given, and its results discussed, the general conclusion being that the use of the suggested solution does give valuable indications of comparative ("mineral") soil fertility such as are not obtained in ordinary soil analysis.

Appended to the account of the work on soils is an account of some experiments on phosphatic manurial materials, comparing the solvent action of alkaline ammonium citrate and dilute citric acid, the result of which is to confirm the views of Tollens and Stutzer, to the effect that, although ammonium citrate may suffice to dissolve "reverted" or "retrograde" phosphate, it does not suffice to indicate "available" phosphate, and that its use ought to be superseded by that of a weak solution of citric acid.

DISCUSSION.

SIR HENRY GILBERT thought all would agree that Dr. Bernard Dyer had entered on a very interesting and very useful line of enquiry. It might be of interest if he referred a little more to the history and difficulties of soil analysis, and if he called attention, in more detail than Dr. Dyer had done, to the chemical statistics of the crops, and to the amounts of the crops themselves, in the case of some of the plots to which Dr. Dyer's results related. At the time of the commencement of the Rothamsted investigations, now more than 50 years ago, the assumption was, that the analysis of the soil, and of the ashes of the crops to be grown, supplied the essential data upon which to found an opinion as to the manurial requirements of the soil. They soon came to the conclusion, however, that such a view was fallacious; and they were somewhat sharply called to account by scientific friends for not adopting such obvious and fully authorised means to a desired end. The discussions at that date as to the nitrogen in soils afforded a good illustration of the difficulty in regard to other constituents also. The contention that the application of nitrogenous manures for the growth of crops was unnecessary was fortified by the results of the determinations of nitrogen in 22 different soils by Dr. Krocker; and it was further confirmed by results obtained on 14 different soils, each analysed by three different chemists, for the Landes-Oekonomie Kollegium at Berlin, under the direction of Professor Magnus. It was calculated that these different soils contained amounts of nitrogen, reckoned as ammonia (though of course they did not exist as such), varying from 3,000 to 18,000 lbs. per acre. In reference to these amounts and the argument founded on them, Sir John Lawes and he had pointed out that if 100 lbs. of nitrogen in the form of ammonium-salts were applied to an acre of soil weighing 4,000,000 lbs., it would only raise the percentage in the soil by 0·0025, or by 1 in 40,000, and yet that in many cases such an addition would give an enormous increase of crop, although the soil might contain thousands of pounds of combined nitrogen. It happened, however, that there were very great discrepancies between the determinations, not only of nitrogen, but of other constituents, in the same soil by the three different analysts; and Professor Magnus himself concluded, in regard to the series, that in the existing state of science, little was to be expected from the analysis of soils; Sir John and he also argued that little advance could be looked for without special investigation and adaptation of methods of analysis to the requirements of the subject.

In 1863, that is a few years after the establishment of Agricultural Experiment Stations in Germany, a Commission of Agricultural Chemists was appointed to consider the question, and settle on a uniform method of soil-analysis, so that the results obtained by different analysts might be comparable. In 1864 Professor E. Wolff reported the conclusions of the Commission; and, so far as solvents were concerned, concentrated cold, and concentrated hot, hydrochloric acids were adopted, though Wolff at the same time suggested that it would be well to use pure water also. Peters, however, proposed that carbonic acid water and dilute acetic acid should also be used. The subject was, he thought, further investigated, but whether or not the suggestion of Peters was finally adopted he did not remember. However, some years later, Hermann von Liebig having asked for samples of some of the plots of the Rothamsted experimental wheat-field, samples from five plots, to three depths of 9 in. each, in each case, were supplied to him; and he determined in them, besides other constituents, the potash and the phosphoric acid, the former in a dilute acetic acid extract, and the latter in a dilute nitric acid extract. These results unmistakably showed differences in the amounts of potash and phosphoric acid in the soils according to the manures employed; and they further brought out the interesting fact that comparatively very little of the applied potash or phosphoric acid had gone below the first 9 in. of soil, and that certainly none had gone into the third depth. This is consistent with the fact that, in a series of complete mineral analyses of the drainage waters from the plots made by the late Dr. Voelcker, only very small amounts of either potash or phosphoric acid were found in them.

Lastly, some years later still, Dr. Carl Schmidt, of Dorpat, made a considerable series of analyses of various soils, in which he used 1 per cent. and 5 per cent. hydrochloric acid cold, 10 per cent. hot, and, lastly, acid, alkali, and fluoric acid; and, of course, the results showed very different amounts of the various constituents according to the solvent used.

Such was the position of the question when he found himself compelled to treat of it in his Oxford lectures about 10 years ago. The course adopted was to bring forward published analyses of very various descriptions of soil; then, after excluding all other constituents, to bring together at one view the actual and comparative amounts of the potash and phosphoric acid only, and to the results as so presented, he endeavoured to give some interpretation by reference to the results of Hermann von Liebig and Professor Carl Schmidt.

More recently, two well-known agricultural chemists in Germany

(Professor Hellriegel and Professor Maercker) finding that, in their capacity of consulting chemists in their respective districts, the analysis of soils as conducted in the ordinary way afforded them little or no guidance as to the advice to be given for their manuring, each instituted an extensive series of vegetation experiments in pots, with a view to the elucidation of the subject. He was not aware, said Sir Henry Gilbert, that either had as yet published his results and conclusions in reference to the point in question. It was of much interest to observe, however, that it was in the course of these experiments, instituted with a totally different object, that Hellriegel first observed nodules on the roots of some of his leguminous plants, and, coincident, greatly increased luxuriance of growth. Thus, it is to the difficulties of soil-analysis, and the proper interpretation of the results, that we owe Hellriegel's investigations on the question of the fixation of free nitrogen. As to Professor Maercker's experiments, he was not able to give an accurate account of their plan; but he was kind enough to show the speaker his large series of pots under experiment in 1891; and, so far as he remembered, his scheme, stated in a few words, was somewhat as follows:—Four characteristic soils of the neighbourhood were taken for experiment, and these were examined by the aid of different solvents, and he believed dilute citric acid was one; and then a great variety of plants, representing, therefore, very various collective capacities, were grown. If, for example, the available condition of the potash in the various soils, for the various descriptions of plant, was the question, care was taken that other constituents than potash should not be wanting, and the plants were grown either without or with known additions of potash. If phosphoric acid was the point of enquiry, a similar plan, *mutatis mutandis*, was adopted. Eventually, the potash or the phosphoric acid, as the case might be, was to be determined by solvents of various strengths, with a view to founding, on the results, a system of examination of soils such as would indicate their requirement or otherwise for different manures.

With reference to the chemical history of the crops of a few of the plots, the potash and phosphoric acid results relating to which Dr. Dyer had given in his paper:—The barley plots, in relation to the crops of which we have the most complete analytical data, are Nos. 2*a* and 4*a*. Each of these has received, during 40 years in succession, an amount of ammonium-salts supplying 43 lbs. of nitrogen per acre per annum. Each has also annually received superphosphate. 2*a* has received no potash from the beginning, but 4*a* has received potash, soda, and magnesia salts every year. They had complete analyses of the ashes of the grain and of the straw of each of these plots, representing respectively periods of 10, 10, 10, and 10 years, or, in all, the

40 years to 1891 inclusive. The Table exhibited showed that whilst over the first 10 years the crop without potash supply yielded 35·6 lbs. of potash per acre per annum, the amount went down in the succeeding decades to 30·9, 19·5, and 15·7 lbs. per acre per annum. Against these amounts, the crops grown with an annual supply of potash showed the following quantities per acre per annum over the successive decades, 53·7, 63·7, 51·5, and 44·8; or, over the whole period of 40 years, the potash-exhausted plot gave 25·4 lbs. of potash per acre per annum in the crops, whilst the crops on the plot with the potash supply gave an average of 53·4 lbs., or more than twice as much. The details further showed that the decline from period to period without supply was, in the grain, proportionally much less than that in the straw; the result, apparently, being that, provided the climatic conditions were favourable, matured grain might be formed almost to the exhaustion of the migratory potash of the rest of the plant, as indicated by the small amount retained in the straw. It was remarkable that with these very great differences in the amounts of potash taken up, in the one case without, and in the other with, an annual supply of it, there was, over the 40 years, not quite one bushel of grain per acre per annum less yielded on the plot without supply than on that with it. Over the last 10 years, however, the yield of grain without supply of potash had gone down very much, and that of straw had been less without supply than with it over each of the 10-yearly periods, and considerably so over the last two decades, and especially in the last. In fact the total growth had become gradually less, and the susceptibility to adverse seasons had been more and more marked in the later years.

The table of Dr. Dyer's results with the entire series of plots showed at a glance the comparative exhaustion or accumulation of both potash and phosphoric acid, whether hydrochloric acid or a 1 per cent. solution of citric acid was used. But confining attention to the two plots, 2*a* and 4*a*, of the crops of which they knew more of the chemical history, it would appear that whilst not more than two-thirds of the potash estimated to be accumulated where it was supplied was taken up even by hydrochloric acid, approximately the whole of the accumulated phosphoric acid was so taken up. Hence it may be judged that much of the residue of the supplied potash must have gone into more fixed combinations within the soil than was the case with the phosphoric acid. Then as to the citric acid results, it was to be observed that they are so far accordant, that the sample of the potash-exhausted plot taken in 1882 showed more potash than that taken in 1889, when the exhaustion was greater; and, again, the citric acid determinations on the soil with potash supply showed more so taken up from the 1889 than from the 1882 sample, the accumulation having, of course, been the greater at the later date. It was further of interest to observe that the amounts determined in the potash-exhausted soil by the citric acid solution were about from three to five times as much as the crops annually took up, which is a fairly consistent relation. Lastly, with reference to these barley soil results, as superphosphate was applied to both plots, the comparison of the amounts taken up on the two was of less interest than in the case of the potash. These two plots, in fact, are of special interest as illustrating in the one case actual exhaustion, and in the other actual accumulation of potash; there being in the one case a loss over the 40 years of about 1018 lbs. of the potash of the soil, and in the other a gain from supply of about 3,180 lbs.

But Dr. Dyer was also working on the soils of some of the plots of the experimental wheat-field, and these would afford some striking illustrations of the effect of accumulated residue of potash supply over a long series of years. Thus, there are four plots, 11, 12, 13, and 14, each of which during the 40 years to 1891 inclusive, received ammonium salts = 86 lbs. nitrogen per acre per annum, and also superphosphate each year. Plot 11 had received no potash either during those 40 years or during the eight preceding years of the experiments. Plot 12 received 587 lbs. of potash during the first eight years, but none during the succeeding 40 years, but it received a soda-salt instead; plot 13 received about 737 lbs. of potash during the first 8 years, and also a liberal supply of potash in each of the succeeding 40 years; lastly, Plot 14 received 566 lbs. of potash during the first 8 years, but none since; but a magnesia salt instead. Thus, Plot 11 had received no potash throughout the 48 years; Plot 12 had received none during the last 40 years, but there would be a residue from the applications during the preceding 8 years; Plot 13 had received potash every year; and Plot 14 no potash during the 40 years; but it would have a residue from the previous applications. We had, therefore, in the comparison of the results obtained on Plots 12 and 14 with only residues of potash from long previous applications, with those on Plot 11 without any potash supply at all, and on Plot 13 with an annual supply of it, the means of judging whether the residue of potash from the applications during the first 8 years had been effective. The determinations of potash in the crops of each of the four 10-yearly periods showed a very great decline in the yield of potash without any supply; considerably larger amounts, and much less decline, on Plots 12 and 14 with potash residue from the early years, and much larger amounts still where potash was annually supplied. Indeed, according to the figures showing the balance of supply and removal, it would be judged that the whole of the potash residues, from the first 8 years' applications on Plots 12 and 14, were at the end of the succeeding 40 years approximately exhausted. But it must be remembered that when referring to Dr. Dyer's results on the barley soils, it was pointed out that even his hydrochloric acid extract did not show more than two-thirds of the estimated accumulation of potash. If, then, the excess of potash taken up by the wheat crops on the plots where there was a potash-residue were to be attributed to that residue, it would appear that the wheat plant had, during the 40 years, taken up more of the accumulated residue than would be susceptible to hydrochloric acid extraction at any one time. Obviously, however, liberation, both of the original and accumulated potash of the soil, would be going on from year to year by weathering, aided probably by the action, in the one case of the sodium, and in the other of the magnesium, salt, annually applied. At any rate, it would seem that Dr. Dyer would find some new points of interest in the investigation of the experimental wheat soils, for from the illustrations given it was evident that we have the conditions of effective residue as well as those of mere exhaustion and accumulation. The suggestion that Dr. Dyer should obtain specimens of a variety of soils from Rothamsted of which the manure and crop history was known, for the purposes of his investigation, originated, he believed, with our President; and he might say that Sir John Lawes and he were always very glad that the collection of samples at Rothamsted, with their long definite history, should be turned to good account by others, for the investigation of points which they had not time to take up.

Mr. WARINGTON said that, as a contribution to the literature of the subject, he might mention that E. Peters, in 1866, determined the phosphoric acid soluble in water, carbonic water, dilute acetic acid, and hydrochloric acid, in four soils; he concluded that the phosphoric acid in soil was chiefly combined with ferric oxide and alumina. In the same year the speaker showed (*J. Chem. Soc.*, 1866, 315) that hydrated ferric oxide or alumina completely decomposed a solution of tricalcium phosphate in carbonic water, the phosphoric acid being taken up while the lime remained in solution; he subsequently showed (*ibid.*, 1868, 1) that soils acted on such a solution in a similar manner. There was, in fact, no doubt that in most soils the phosphoric acid exists as a basic ferric phosphate, and that the great insolubility of soil phosphates is due to this cause.

Dr. DYER did not refer to Grandeau's view, that the available phosphoric acid and bases in a soil are in combination with humus, and that by acidifying a soil and then extracting with ammonia, the whole of the matters so combined may be obtained in solution and estimated. Nor did he mention Schlœsing's method of extracting the available potash, by agitating the soil with water to which small quantities of nitric acid are added from time to time till a distinct permanent acidity is reached. Nor Petermann's use of an alkaline ammonium citrate to discriminate between the phosphoric acid belonging to the rock from which the soil was formed and that arising from manure.

If the difficulties in the determination of the acidity of root sap are similar to those met with in determining the acidity of lemon-juice and wine lees (*Trans. Chem. Soc.*, 1875, 929, 937, 966), the result will depend a good deal on how the experiment is conducted. If the roots are dried, the acidity found may be below the truth, as the fixed organic acids will decompose chlorides and other salts of volatile acids during drying. It might be well to determine the amount of *active* acid, that, for instance, which is capable of decomposing calcium or magnesium carbonate, rather than the total acidity shown by neutralising with soda, which is sure to be a larger figure. It also appears desirable that the amount of combined organic acid should be determined.

The acidity of the various specimens of root sap exhibits considerable variations, the meaning of which is at present obscure. In one instance the result is certainly not what we should expect. Seven determinations in the sap of turnip and swede roots give a mean of 0·55 per cent. of acid, reckoned as citric; while seven determinations in the case of mangel and beet give 0·50 per cent. We should have expected the latter crops to have far surpassed the former in acidity, as mangels are well able to appropriate the combined phosphates of the soil, and stand in no need of phosphatic manure, while the turnip crop is of an exactly opposite character. Mangel leaves are known to contain soluble oxalates.

If agricultural chemists agree to accept a 1 per cent. solution of citric acid as the agent in determining the available mineral plant food in a soil, a difficulty will arise when working on soils containing calcium carbonate or other easily acted on base, as in this case the citric acid will be neutralised and weakened. In such cases more citric acid might be added if the amount present never exceeded 1 per cent., and finally reached that point; but we should clearly in this case be acting on the soil with a mixture of citric acid and a citrate.

The question whether free citric acid, or a citrate, or a mixture of both, should be used as solvent is decided by Dr. Dyer in favour of citric acid; the evidence, however, seemed to point to a mixture of both as most satisfactory. Some combined organic acid is doubtless present in the root sap, and this quantity must be continually renewed by the action of this sap on the bases in the soil. Dr. Dyer, at the close of his paper, compared the action of citric acid and of ammonium citrate on a large series of phosphates. It appears that the action of ammonium citrate on many calcium phosphates is too little; but, on the other hand, surely the action of the free citric acid was in these cases too great. It was certainly contrary to our present experience to suppose that 100 lbs. of powdered apatite would supply 12 lbs. of "soluble phosphate" to a crop, which is the result shown by attacking it with 1 per cent. free citric acid. Full justice was not done to Wagner's proposal to use a solution containing 10 grams of free citric acid and 150 grams of combined citric acid per litre, the solution when used to be *diluted to one-fifth.* A solution of this formula was selected by Wagner after many trials because the proportions of soluble phosphate it yielded with certain typical phosphates were practically the same as the proportions of available phosphate found by actual experiments with these phosphates as manure for plants.

On turning to the results obtained by Dr. Dyer on treating the Rothamsted experimental barley soils with a 1 per cent. citric acid solution, we find that this agent succeeds very well in discriminating between the natural phosphates and potash of the soil and the residues of phosphatic and potassic manure; but its action does not exactly correspond to that of the barley roots. The citric acid is, in fact, a better solvent for phosphates, and a worse solvent for potash, than the barley roots. In 1889 the barley crop showed a deficiency of 13 bushels in the absence of phosphatic manure, although citric acid showed the presence of 152 lbs. of soluble phosphoric acid per acre. The barley crop, on the other hand, showed no deficiency due to the absence of potash, although citric acid showed only 57 lbs. per acre. The case becomes stronger when it is recollected that a barley crop takes up more potash than phosphoric acid.

It is shown in the paper that nearly the whole of the excess of phosphoric acid applied as superphosphate is found soluble in hydrochloric acid in the first 9 in. of soil, and that about one-half of this amount is soluble in citric acid. On the other hand, of the excess of potash applied as potassium salts, only two-thirds remains soluble in hydrochloric acid in the first 9 in., and of this quantity a little more than one-third is soluble in citric acid. The case is entirely altered when we come to the farmyard manure plot. According to the published estimate of the composition of the farmyard manure, this plot receives about one-fifth more phosphoric acid than is applied as superphosphate, and more than twice as much potash as is applied as potassium salts. We find, however, in the first 9 in. of the farmyard manure plot less phosphoric acid than where superphosphate has been used, the deficiency per acre amounting to about 1,000 lbs. If we regard the potash the result is still more striking, the percentage of potash soluble in citric acid being no greater than where less than half the amount of potash had been applied as potassium salts, while the potash soluble in hydrochloric acid is less than on any plot save two in the whole field. The calculation per acre shows that, notwithstanding the supposed application of 8,930 lbs. of potash per acre, the farmyard manure plot contains less potash soluble in hydrochloric acid than any plot in the field save one. The question certainly calls for investigation. Is the published estimate of the composition of the farmyard manure excessive? Has the large amount of decomposing organic matter on this plot kept the phosphoric acid, and especially the potash, in a soluble form, and carried them into the subsoil? Or has the silica of the straw helped to form insoluble compounds with the potash?

The amounts of total potash, and of potash soluble in hydrochloric acid, did not form a very regular series, and it was difficult to form conclusions from them. According to the figures, the use of nitrate of soda had been attended with a serious loss of potash, which we must suppose to have passed into the subsoil. This point certainly demands further enquiry. The method used by Dr. Dyer to extract the potash soluble in hydrochloric acid does not seem satisfactory, no definite time of digestion being specified. In the official United States method, 5 grams of soil are digested with 50 c.c. of hydrochloric acid, sp. gr. 1·115, in a stoppered bottle, during 40 hours at 100°. In other recognised methods a definite period of digestion is always adhered to.

Mr. Lloyd, referring to experiments which he had had occasion to make with an object similar to that which the author of the paper had in view, said that he had met with the difficulty to which Mr. Warington referred, arising from the presence of varying amounts of chalk in soils; it was, however, overcome by first neutralising the soil. Using decinormal hydrochloric acid, he had found that the method gave useful practical results. He then drew attention to experiments made by the late Dr. Voelcker at Woburn, which showed that phosphate of alumina was a much better fertilising agent than bone phosphate, and pointed out that this result did not agree with Dr. Dyer's conclusion that Redonda phosphate, containing much phosphate of alumina, gave up only 9 per cent., while bone phosphate gave up 100 per cent. on treatment with the citric solution.

Dr. J. Voelcker emphasised the importance of studying the behaviour of soils under a great variety of conditions, and also of using air dried soils, such as Dr. Dyer had operated on, instead of soil dried at 100°, as drying was undoubtedly productive of change.

Mr. Hughes thought that sufficient value had not been attached by the author to the analysis of soils as hitherto carried on by the old methods. He asked why Dr. Dyer had selected for examination a soil on which a crop specially requiring nitrogen, and not potash or phosphoric acid, had been raised. He questioned the necessity of shaking up so much as Dr. Dyer recommended.

Mr. Sibson said it was necessary to remember that the available plant food will vary with the order of the crops, the material differences discovered in the acidity of many root saps indicating this, although only one factor amongst those causing the remarkable variations in ability exhibited by plants of acquiring their supply of nutriment, which must obviously complicate any process of estimating available constituents. Another important question was as to the effect of a 1 per cent. citric acid solution on the residual phosphoric acid from a previous dressing of superphosphate, which had combined with the oxide of iron in the soil, this being known to possess an inferior fertilising value compared with recently applied phosphate.

Dr. Dyer, in reply, thanked Sir Henry Gilbert and Mr. Warington for having supplemented his account of the literature of the subject, and admitted the difficulties advanced by the latter as to the interpretation of the sap acidity figures, and also the possibility that some other solution than the one he had used might, at any rate in some cases, better represent the action of the sap. It was to be remembered, however, that any method that might be adopted must be an arbitrary one, and that the object to be attained was to select the best arbitrary solvent for all-round use in soil analysis. At all events, the 1 per cent. solution of citric acid appeared to afford fairly consistent results in the case of the soil examined. The difficulty as to soils rich in carbonate of lime was one which, as Mr. Lloyd pointed out, might be met by using an additional quantity of citric acid corresponding to the carbonate of lime present—a tolerably simple matter.

With regard to the apparent relative power of the barley roots to assimilate phosphoric acid and potash, to which Mr. Warington had alluded, it was no doubt a fact that in face of a comparatively small quantity of soluble potash indicated on certain plots, the crop suffered far less than on the phosphoric-acid-starved plots, although the actual quantity of soluble phosphoric acid in the latter exceeded that of the soluble potash on the potash-starved plots. But in the text of the paper it was pointed out that the samples of soil were drawn in the autumn, just after the crop had withdrawn its yearly share of available potash, and before the winter had done its work of "weathering"—always assumed to be of great importance in the liberation of natural potash.

The small quantity of phosphoric acid and potash found in the farmyard manure plots was, no doubt, strikingly small compared with the estimated additions and theoretical accumulations. Possibly, as Mr. Warington suggested, the estimates of addition in manure might be too high, but it seemed more probable that on these plots more fertilising matter had been carried downward than in the case of the artificially manured plots. Unfortunately no subsoil samples had been taken, so that what had occurred below the top 9 inches was so far unknown.

The figures for total potash, representing chiefly undecomposed potassic minerals (such as felspar, &c.), corresponded to such enormous quantities of potash (frequently 1·5 per cent. of the dry soil) that comparatively small variations, one- or two- or three-tenths per cent., such as would occur in different parts of the same field, altogether upset and overwhelmed the minor differences in presumably "available" potash, and were of very small significance. Nor did he attach much importance to the solubility in hydrochloric acid; it was, as he had pointed out, largely a function of the quantity of acid used and the time of digestion. The results might, perhaps, have been more consistent had he taken more than 10 c.c. of strong acid for 10 grams of soil, a quantity which Mr. Warington thought too small, though it was to be remembered that after this had been slowly evaporated off on a water bath, 10 c.c. more of strong nitric acid were used. But seeing that even this quantity of acid extracted tons of potash per acre from soil practically shown to be now suffering from potash starvation, it did not seem to matter whether a little more or less were got out. What the results, however, did seem to show was that the quantity of potash soluble in hydrochloric acid was apparently a useless and unreliable datum in soil analysis—useless, perhaps, in cases of extreme richness or extreme poverty.

With regard to the question asked by Mr. Hughes, the barley field had been chosen because both its history and the yield of its various plots indicated both the phosphatic and potassic starvation and repletion in various phases, though, no doubt if, under the same conditions, a turnip field could have been selected, it would have been preferable. There was obviously room for a great deal more work in the same direction; he was at present engaged in examining the Rothamsted wheat soils.

The PRESIDENT said that Dr. Dyer's paper undoubtedly dealt with a subject of great interest, the determination of available as distinguished from total mineral plant food being obviously of great importance, not only as a means of arriving at estimates of the fertility of soils, but also in dealing with that very difficult question—the value of unexhausted improvements. All methods devised to such an end were necessarily empirical, and their value would only be ascertained after long experience; were it not that the Rothamsted soils afforded the means of testing the conclusions arrived at, it would be difficult to say whether Dr. Dyer's method was a good one for practical purposes and in advance of those previously suggested; the results Dr. Dyer had arrived at were, however, of a character which a knowledge of the soils examined appeared to justify. He knew, said the President, from conversation with Sir John Lawes, that this was Sir John's view; and, moreover, that Sir John Lawes took the greatest interest in the work, and was of opinion that the prosecution of the inquiry on lines such as were indicated in the paper was of the greatest importance to agricultural science. Whatever the ultimate opinion as to the value of the method advocated by Dr. Dyer, his paper would have the effect of calling attention to the subject, and to the opportunities it afforded for research. It was important that chemists who desired to study these problems should realise what a mine existed at Rothamsted from which information could be gathered by all who were prepared to patiently devote themselves to inquiries such as Dr. Dyer had indicated; there—and nowhere else in the world—soils were at disposal, awaiting examination, the history of which, during the past 50 years, was accurately recorded, and such an opportunity ought not to be neglected.

115. "The behaviour of the more stable oxides at high temperatures. Part II." By A. A. Read.

The author has heated the more stable oxides at a temperature of about 1750°, and records the extent to which decomposition (if any) occurred at that temperature. He finds that Sb_2O_5 is converted into S_2bO_3, V_2O_5 into V_2O_3, Fe_2O_3 into Fe_3O_4, and that the oxides of cobalt and nickel give up the whole of their oxygen, being reduced to the metallic state. In the case of molybdic oxide, uranium trioxide and stannic oxide, a slight loss of oxygen occurred. The oxides CaO, SrO, BaO,MgO, ZnO, CdO, Al_2O_3, In_2O_3, Di_2O_3, CeO_2, ZrO_2, TiO_2, PbO, Bi_2O_3, Nb_2O_5, Ta_2O_5 and WO_3 were unaltered.

116. "The stability of the oxides considered in relation to the periodic law." By G. H. Bailey, D.Sc., Ph.D.

Taking the temperature of decomposition as an index of stability, the author arrives at the following generalisations as to the stability of the typical oxides in relation to the atomic weights of the elements from which they are derived:—

(1.) That in the *even* series the oxides are *more* stable the higher the atomic weight.

(2.) That in the *odd* series they are *less* stable the higher the atomic weight.

He then proceeds to consider the extent to which the various elements combine with oxygen, and draws the conclusions—

(1.) That in the even series the higher the atomic weight, the greater *in extension* is the tendency to combine with oxygen.
(2.) That in the odd series there is little tendency to form peroxides, but such as exist show that the tendency to form such oxides *decreases* as the atomic weight rises.

He is of opinion that the diametrically opposite bearing of the odd and even series in regard to the stability of the oxides is an indication that the attraction for oxygen is influenced by the magnetic state of the elements, those of the even series being usually regarded as paramagnetic, and those of the odd series as diamagnetic.

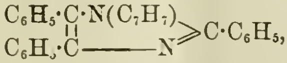
117. "Interaction of benzil and benzylamine in presence of zinc chloride: a preliminary note." By Francis R. Japp, F.R.S., and W. B. Davidson, M.A., B.Sc.

When benzil, benzylamine and zinc chloride are heated together at 100°, a product is obtained from which the authors have isolated three compounds: (1) tetraphenylazine, $C_{28}H_{20}N_2$ (m. p. 246°); (2) a compound melting at 164°, and having the formula $C_{28}H_{22}N_2$; and (3) a double compound of an organic chloride with zinc chloride, which is deposited from its alcoholic solution, on the addition of ether, in lustrous crystals of the formula $(C_{35}H_{29}N_2Cl)_2ZnCl_2,3(C_2H_5)_2O$, melting at 248°.

When exposed to the air, these crystals give off their "ether of crystallisation." The chloride $C_{35}H_{29}N_2Cl$, when isolated from the zinc compound, forms prisms which, when rapidly heated, melt at 253°.

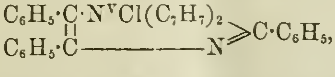
The compound $C_{28}H_{22}N_2$ is a tertiary amine, and unites directly with benzyl chloride to form the chloride $C_{35}H_{29}N_2Cl$, which is therefore a quarternary ammonium chloride.

Suspecting that these two compounds might be benzyl-derivatives of lophine, the authors heated lophine with benzyl chloride, and found that the same two substances were formed in the interaction. The compound $C_{28}H_{22}N_2$ is, therefore, *benzyllophine*,



$$\left.\begin{array}{l} C_6H_5\cdot C\cdot N(C_7H_7) \\ \quad\quad\;\; \| \\ C_6H_5\cdot C\text{———}N \end{array}\right\rangle C\cdot C_6H_5,$$

and the chloride $C_{35}H_{29}N_2Cl$ is *dibenzyllophinium chloride*,



$$\left.\begin{array}{l} C_6H_5\cdot C\cdot N^{V}Cl(C_7H_7)_2 \\ \quad\quad\;\; \| \\ C_6H_5\cdot C\text{—————}N \end{array}\right\rangle C\cdot C_6H_5,$$

the latter corresponding with Kühn's diethyllophinium iodide.

The following equations express the formation of the two compounds :—

1. $C_{14}H_{10}O_2 + 2C_6H_5{\cdot}CH_2{\cdot}NH_2 = C_{28}H_{22}N_2 + 2H_2O + H_2$,

2. $2C_{14}H_{10}O_2 + 6C_6H_5{\cdot}CH_2{\cdot}NH_2 + ZnCl_2 =$
$2C_{35}H_{29}N_3Cl + 2NH_3 + Zn(OH)_2 + 2H_2O + 2H_2$.

These compounds yield the platinichlorides $(C_{28}H_{22}N_2,HCl)_2PtCl_4$ and $(C_{35}H_{29}N_2Cl)_2PtCl_4$.

The authors propose to ascertain whether a similar interaction occurs with other primary amines of the formula $R'{\cdot}CH_2{\cdot}NH_2$ and other diketones.

At the next meeting, on March 1st, the following paper will be read :—

"The äerial oxidation of turpentine and essential oils." By C. T. Kingzett.

Harrison and Sons, Printers in Ordinary to Her Majesty, St. Martin's Lane.

Issued 10/3/1894.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

No. 135. Session 1893–94.

March 1st, 1894. Dr. Armstrong, President, in the Chair.

Messrs. Henry E. Burgess, F. D. Chattaway, Walter Grafton, D. H. Jackson and A. Lapworth were formally admitted Fellows of the Society.

The list of Officers and Council nominated by the Council for election, at the Anniversary Meeting in March, was read from the Chair.

Certificates were read for the first time in favour of Messrs. Robert William Buttemer, St. Mary's Godalming; George Hugh Gabb, 91, Elgin Avenue, W.; Matthew A. Parker, 13, Hamilton Crescent, Partick, Glasgow; James Swinburne, 4, Hatherley Road, Kew Gardens.

The following papers were read:—

118. "The aerial oxidation of terpenes and essential oils." By C. T. Kingzett.

After referring to his previous work on the subject, the author describes the results of an examination of a number of oily and semi-resinous products obtained on oxidising various turpentines by passing air either into the oil or into a mixture of the oil and water.

It is found that when any terpene is oxidised by air in the presence of water, or when the oxidised oil is shaken up with water, the aqueous solution always contains hydrogen peroxide and a substance that may be obtained by evaporating off the water, this latter at the ordinary temperature of the atmosphere having the consistency of soft pitch, and being very bitter to the taste. Analyses are quoted of a considerable number of samples prepared from various oils, showing that the composition of the substance is approximately represented by the formula $C_{10}H_{16}O_3$. It appears to yield some cymene when distilled with dilute sulphuric acid.

When Russian turpentine is oxidised in the presence of water and the aqueous solution is distilled, a small quantity of a light-yellow coloured oil passes over, which darkens on standing, and has a characteristic smell something like that of thymol. About 23 grams of this oil were obtained by distilling 25 litres of the fluid. On analysis it gave numbers approximating to those corresponding with the formula $C_{10}H_{14}O$; but on distilling this oil, after drying it over calcium chloride, only a portion passed over between 180° and 205°, leaving a viscid residue.

When oxidised Russian turpentine is evaporated down on the water bath until all the volatile matter has apparently been driven off, and the residue is dried at 100°, a dark brown translucent mass is obtained, which, when cold, is quite hard and brittle; an analysis of this substance shows that it has a composition represented roughly by the formula $C_{10}H_{14}O_2$. Other oils afford somewhat similar results.

The author believes that in the limited oxidation (by air) of essential oils the terpene grouping is not broken down, as he has ascertained, by special investigation, that the acetic acid which sometimes accompanies the other products when the process is conducted in the presence of water is not observed to be present if only pure or refined oils are employed, and he has not met with any product which can be assumed to contain less than 10 atoms of carbon in the molecule.

The author does not propose to continue the study of these substances, and will be pleased to supply any quantity of the chief products to any chemist who may desire to examine them.

The experiments have been carried out with the assistance of Mr. D. Homfray, B.Sc.

119. "The amides of sodium, potassium and lithium." By A. W. Titherley, B.Sc.

Sodamide ($NaNH_2$) was prepared by the action of dry ammonia on sodium heated to 300—400° in a polished iron retort; as obtained in this way, sodamide is a white mass, having a distinctly crystalline structure; the brown colour of the substance prepared by former observers is principally due to organic impurity in the sodium. The product was proved to have the composition represented by the formula $NaNH_2$ by synthetical experiments. When heated at 500—600°, sodamide decomposes into sodium, nitrogen and hydrogen, but no sodium nitride (Na_3N) is obtained; in fact all attempts to prepare this compound were unsuccessful. The same is true of disodium amide (Na_2NH) which cannot be produced by the action of sodium on sodamide; the metal, however, dissolves in the molten sodamide, forming a blue product, the exact composition of which could not be ascertained.

By acting with ammonia on heated sodium oxide a mixture of sodium hydroxide and sodamide was obtained.

Potassamide (KNH_2) may be obtained as a white solid by using the same method as that used in preparing sodamide. It is less brittle and softer than sodamide, and it melts at a higher temperature. It is capable of crystallising, and sublimes when heated to about 400°. No potassium nitride (K_3N) could be obtained by heating potassamide, the compound breaking up into potassium, nitrogen and hydrogen.

Lithamide ($LiNH_2$) may be obtained by the same method as sodamide and potassamide. It is a white crystaline solid. Both sodamide and potassamide decompose silica when heated with it, silicon nitride and sodium silicate apparently being formed. A similar change occurs with boric oxide, boron nitride being one of the products.

Nitrosyl chloride acts on sodamide, forming potassium chloride, nitrogen and water.

When sodamide is heated with alkylic haloids, ammonia is produced and not the corresponding amine.

ADDITIONS TO THE LIBRARY.

I. *Donations.*

Electricity in the Service of Man: A Popular and Practical Treatise on the Applications of Electricity in Modern Life, by R. Wormell (from the German of A. R. v. Urbanitzky. Revised and enlarged by R. M. Walmsley: London, Paris and Melbourne, 1893.
From the Authors and Publishers.

Manures and the Principles of Manuring, by C. M. Aikman: Edinburgh and London, 1894. From the Author and Publishers.

Johnston's Elements of Agricultural Chemistry: from the edition by C. A. Cameron. Revised and in great part re-written by C. M. Aikman. 17th edition: Edinburgh and London, 1894.
From the Editor and Publishers.

United States Geological Survey:—Mineral Resources of the United States—Calendar year 1891, by D. T. Day: Washington, 1893. From the Survey.

Royal Society of Canada: Proceedings and Transactions, Vol. X., for the year 1892: Ottawa, 1893. From the Society.

Pamphlets: from the Authors.

Extrait d'une Étude de l'Acide tétrafHique (tartrique) et de ses composés salins, par E. J. Maumené: Chateauroux, 1894.

Preliminary Survey of Eucalyptus Oils of Victoria, by W. P. Wilkinson: Melbourne, 1893.

The Estimation of Sugars in Condensed Milk, by W. D. Bigelow and K. P. McElroy: Easton, Pa., 1893.

At the next meeting, on March 15th, the following papers will be read:—

"The Action of Hydroxylamine on Formic Aldehyde." By Prof. Dunstan and Dr. Bossi.

"Derivatives of Camphopyric Acid." By Messrs. J. E. Marsh and J. A. Gardner.

"Halogen Derivatives of Camphene." By Messrs. J. E. Marsh and J. A. Gardner.

ANNUAL GENERAL MEETING.

March 22, at 8 P.M.

Harrison and Sons, Printers in Ordinary to Her Majesty, St. Martin's Lane.

Issued 17/4/1894.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

No. 136. Session 1893-94.

March 15th, 1894. Dr. Armstrong, President, in the Chair.

Messrs. William G. Boul, Frank Evershed, and G. N. Huntly were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. George Dixon, Trinity College, Cambridge; Nicholas Eumorfopoulos, 1, Kensington Park Gardens, W.; G. S. Newth, 29, Mount Park Road, Ealing; Alfred Nixon, 14, Entwistle Street, Moss Side, Manchester; Herbert Harold Robjohns, King's School, Pontefract, Yorks; George Ryce, B.A., Rathmore Place, Cork; John George Spenzer, M.D., Ph.D., 370, Central Avenue, Cleveland, U.S.A.; Arthur Swainson, The Grammar School, Beverley; Edward Cumming Thompson, 5, Gubyon Avenue, Herne Hill, S.E.

Of the following papers those marked * were read:—

*120. "Formaldoxime." By Wyndham R. Dunstan, F.R.S., and A. L. Bossi, B.Sc., Ph.D.

Our knowledge of this compound, the first member of the series of paraffinic aldoximes, is very limited, being in fact represented only by the observations made a few years ago by Scholl (*Ber.*, **24**, 573), who found that the chief product of the interaction of formaldehyde and hydroxylamine was a white amorphous solid, which behaved as a polymeride of formaldoxime. The aldoxime itself Scholl was only able to study as a solution, obtained by heating the polymeride with certain liquids, and as a gas obtained by heating the dry polymeride. He showed that the substance in these two forms has a molecular weight corresponding with the formula $CH_2\colon NOH$, that it is a powerful reducing agent, and in its other properties behaves as an aldoxime.

The authors have obtained formaldoxime as a colourless, highly refractive liquid, boiling between 84—85°, by extracting with ether a warm, freshly prepared mixture of aqueous formaldehyde and hydroxylamine (hydroxylamine hydrochloride with the calculated amount of sodium carbonate), and then fractionally distilling the ethereal solution. All attempts to crystallise the liquid have failed. When cooled it quickly changes into the solid polymeride, and even at the ordinary temperature it cannot be kept for long without polymerisation taking place. It has a slight curious odour, which is difficult to describe, and it burns with a livid yellow flame, producing much hydrogen cyanide, $CH_2NOH = H_2O + HCN$. A determination of the molecular weight of the liquid by Raoult's method, using acetic acid as the solvent, gave a result corresponding with the formula $CH_2{:}N{\cdot}OH$.

Formaldoxime undergoes quantitative hydrolysis into formaldehyde and hydroxylamine when it is digested with cold concentrated hydrochloric acid, but when it is heated with dilute acids, formic acid and ammonia are also produced, owing to the previous conversion of some of the aldoxime into formamide, $HCONH_2$, a mode of isomeric change which is characteristic of these aldoximes.

Formaldoxime readily decomposes into its nitrile (hydrogen cyanide) and water when it is heated with aqueous alkalis, or when it is acted on by acetic chloride. It forms unstable derivatives with the alkali metals; the sodium derivative, CH_2NONa, is crystalline; it explodes when heated, and very readily loses water, becoming sodium cyanide.

When warmed with aqueous solutions of salts of silver, gold, copper, and mercury, formaldoxime acts as a powerful reducing agent. With cold aqueous copper sulphate it furnishes a dark green solution, which soon deposits crystals of a remarkable copper salt, and these, when kept, spontaneously evolve nitric oxide. This compound is still under examination.

When dry hydrogen chloride is led into the well dried ethereal solution of formaldoxime, the *hydrochloride* separates as an amorphous solid, which, however, may be readily crystallised from its solution in a mixture of alcohol and ether. When analysed, the well defined prismatic crystals (m. p. 136°) furnished data corresponding with the formula $(CH_2NOH)_3HCl$.

This remarkable salt, which can easily be obtained pure, constitutes a convenient source for the preparation of pure formaldoxime. It dissociates into the aldoxime and hydrochloric acid when it is dissolved in water, and if the solution is neutralised, pure formaldoxime may be recovered by distillation. The salt dissolves when warmed with aniline, and the formaldoxime can then be distilled from the mixture. A similar crystalline *hydrobromide*, $(CH_2NOH)_3HBr$, m. p. 120°, and also a *hydriodide*, have been prepared.

By the spontaneous evaporation of a mixture of acetic anhydride and an ethereal solution of formaldoxime, a stable crystalline *acetformaldoxime*, $CH_2NO(CH_3CO)$, was obtained. A molecular weight determination, using acetic acid as the solvent, gave a result corresponding with the formula $(CH_2NO{\cdot}CH_3CO)_3$. It melts sharply at 133°. On hydrolysis it yields chiefly formaldehyde, acetic acid, and hydroxylamine. A crystalline *benzoic derivative* of formaldoxime was also prepared. This is a stable substance melting at 168·5°.

Having regard to the theoretical importance which attaches to a complete knowledge of the properties of formaldoxime, the authors are further investigating some of the compounds now described, and are preparing other derivatives.

*121. "Derivatives of camphene containing halogens." By J. E. Marsh and J. A. Gardner.

Methods are described for obtaining such derivatives (1) by the action of halogens on camphene-phosphonic acids, (2) by the hydrolysis of substituted camphene-phosphonic acids, (3) by direct substitution of hydrogen in the hydrocarbon, (4) by the splitting off of halhydride from additive compounds. This last method affords a means of obtaining substituted camphenes from camphor. According to Pfaundler, if the dichloride is heated, it loses hydrogen chloride, yielding a compound of the formula $C_{10}H_{15}Cl$, the existence of which has, however, been denied by Spitzer. The authors find that chlorocamphene is readily obtained from the product of the action of phosphorus pentachloride on camphor, when it is boiled with aniline, or better, with quinoline. The chlorocamphene thus obtained is a very stable compound, remaining unchanged when heated at 250° with quinoline. It distils at 198—200°, and is slightly lævorotatory. On distillation it collects in the receiver as a solid of low melting point.

The compound of the formula $C_{10}H_{16}Cl_2$ distils almost unchanged. But the distillate is found to have a much greater rotatory power than the original substance; and the rotatory power is found to increase on successive distillations: thus a substance having a rotatory power $[\alpha]_D = -9°$, after one distillation had a rotatory power of $-19°$, after two of $-30°$, and after three of $-35°$. The explanation of this effect has yet to be found: it may be the result of an isomeric change.

Bromocamphene may be obtained from camphor by mixing phosphorus trichloride and bromine in molecular proportions, and gradually adding camphor. At first a considerable amount of a red solid, probably a compound of the formula $C_{10}H_{16}OBr_2$ is formed, but after a time this disappears and a clear, almost colourless liquid is obtained. From this a new substance, represented by the formula $C_{10}H_{16}Br_4$, was isolated; this forms large, colourless crystals, resembling dipentene tetrabromide, which melt at 171°. The compound $C_{10}H_{16}Br_2$ was not obtained.

The action of chlorine on camphene in presence of alcohol is somewhat violent, and does not only afford chlorocamphene, but yields a number of liquid chlorinated products which are difficult to separate. The product, boiling at about 220°, nearly corresponds to a chlorocamphene. The boiling point is, however, 20° higher than that of the chlorocamphene prepared from camphor.

*122. "A sulphate of oxamide." By J. E. Marsh.

Oxamide is known to behave as a weak acid and to form salts with metallic oxides, but apparently it has not been observed to combine with acids to form salts. I find, however, that oxamide dissolves in strong sulphuric acid without decomposing, and, on adding water, it is precipitated apparently unchanged, as 92 and 94 per cent. were thus recovered in two experiments. The solution of oxamide in strong sulphuric acid may be heated to above 140° without decomposition occurring, although when oxalic acid is heated with strong sulphuric acid, it decomposes briskly at 100°. In an experiment in which 2·5 grams of oxamide, together with 10 c.c. of strong sulphuric acid, were heated at 100° on the water bath, a solution was obtained, from which, on cooling, a quantity of large, colourless, transparent crystals were deposited. It was difficult to get the crystals free from adherent acid, as no solvent could be used to wash it away without instantly decomposing the compound; they were, therefore, filtered off and dried quickly with blotting paper. Analysis showed the crystals to be disulphate of oxamide, $(CONH_2H_2SO_4)_2$. Fuming nitric acid dissolves the crystals without precipitating oxamide, the solution undergoing violent decomposition after standing a few minutes.

Oxamic acid, $CO(NH_2)\cdot COOH$, also dissolves in strong sulphuric acid, and the solution deposits crystals on cooling. Water does not cause any precipitation in this solution.

Oxamethane, $CO(NH_2)\cdot CO_2Et$, is completely hydrolysed by dissolution in strong sulphuric acid, barium oxamate, $(NH_2C_2O_3)_2Ba + 3H_2O$, being obtained from the liquid on neutralising it with barium carbonate.

*123. "Fluoplumbates and free fluorine. By Bohuslav Brauner, Ph.D.

By substituting fluorine for oxygen or an acid radicle in several compounds of tetrad lead, by acting on the oxide with fluorhydric acid and potassium hydrogen fluoride, the salt $3KF \cdot HF \cdot PbF_4$ was obtained as a first member of the series of triple plumbic fluorides (*fluoplumbates*). This salt crystallises in colourless, needle-shaped forms, analogous in composition to, and isomorphous with, the monoclinic triple stannic fluoride (fluostannate), $3KF \cdot HF \cdot SnF_4$, obtained by Marignac. On heating at about 230° the lead salt loses hydrogen fluoride, and at a higher temperature fluorine is evolved. On attacking the triple fluoride with concentrated sulphuric acid, a lemon-coloured substance is obtained, which appears to be *lead tetrafluoride.*

124. "The action of nitrosyl chloride on unsaturated compounds." By William A. Tilden, F.R.S., and Martin O. Forster.

The authors have continued the work begun by Tilden and Sudborough (Trans., 1893, 479), and have extended the investigation to unsaturated acids and several phenols and their ethers. Some unexpected anomalies have been encountered, inasmuch as many unsaturated compounds, which instantly unite with bromine, are found to be indifferent to nitrosyl chloride or are attacked very slowly, forming chlorinated products instead of nitroso-chlorides. Thus, while phenylethylene (cinnamene) and diphenylethylene (stilbene) combine with nitrosyl chloride, phenanthrene and acenaphthylene do not, phenanthrene yielding a considerable quantity of chloro-substitution derivatives. Again, while the compounds obtained from the majority of the olefines behave like hydroximes, which, on hydrolysis, yield hydroxylamine, a number of the others—those from cinnamene, oleic acid and anethol, for example—do not give hydroxylamine, neither do they afford Liebermann's test. These cases, therefore, require further investigation before the constitution of the "nitroso-chlorides" can be regarded as settled.

125. "Note on the action of nitrosyl chloride on amido-derivatives of benzenoid hydrocarbons." By William A. Tilden, F.R.S., and J. H. Millar.

This wide field of work has been explored rather rapidly, with the object of ascertaining the general nature of the interactions which nitrosyl chloride is capable of entering into with benzenoid amines. We are now in a position to state that in the great majority of cases nitrosyl chloride behaves towards these compounds as the chloride of nitrous acid, giving rise either to nitroso-compounds or diazo-compounds. In a few cases only it produces the simple effect of chlorination.

Reserving details for a future communication, the following facts may be regarded as established. In applying the agent, the solvent used has been generally ether, which is very slowly attacked by it, even in daylight. In a few cases glacial acetic acid has been used. A low temperature is usually necessary.

Examples of Diazotisation.—Aniline in ether readily yields diazoamidobenzene, crystallising in characteristic form and melting at 97°.

Parachloraniline in ether gives *pp*-dichlorodiazoamido-benzene, melting at 126—127° (Griess gave the melting point 125°, Meldola and Streatfield 130°, Trans., **53**, 670).

Paranitraniline gave *pp*-dinitrodiazoamidobenzene, m. p. 224°.

Orthonitraniline and *metanitraniline* give the corresponding very unstable diazochlorides.

Examples of the Formation of Nitroso-compounds.—Methylaniline yields methylphenylnitrosamine, $C_6H_5N{\cdot}NO{\cdot}CH_3$, which separates from the cold ethereal solution in the form of the hydrochloride as a colourless, crystalline mass.

Dimethylaniline gives dimethylparanitrosoaniline hydrochloride, from which the base $C_6H_4(NO){\cdot}N(CH_3)_2$, m. p. 85°, was prepared.

Diphenylamine.—Diphenylnitrosamine is obtained in brilliant, nearly colourless crystals, m. p. 66·5°.

Examples of the Formation of Diazoimides.—Phenylhydrazine.—The formation of the diazoimide by the action of nitrosyl chloride on the acetic acid solution of this base has already been described (Trans., 1893, 256).

α-Naphthylhydrazine and *β-naphthylhydrazine* both yield the corresponding diazoimides as easily fusible compounds volatile in steam.

Example of Chlorination.—Acetanilide, dissolved in glacial acetic acid, yields, when saturated with nitrosyl chloride, parachloracetanilide, m. p. 173°, as the only product. By protracted action, the nitroso-compound, $C_6H_3Cl_2{\cdot}N{\cdot}NO{\cdot}C_2H_3O$, m. p. 142·5°, appears to be formed.

126. "Action of aluminium chloride on heptylic chloride; a correction." By F. Stanley Kipping, Ph.D., D.Sc.

It has been ascertained that the ketone of the composition $C_{14}H_{20}O$, referred to in a previous note (*Proc.*, 128, 208), is paraheptyltoluene, $C_6H_{13}{\cdot}CO{\cdot}C_6H_4{\cdot}CH_3$, and that it is not formed from heptylic chloride alone, but by the normal interaction of the acid chloride and toluene in presence of aluminium chloride. The first communication was made in ignorance of the fact that toluene was present, and it was not until the constitution of the ketone had been determined that it was found that the "petroleum," which the author's assistant had employed as a diluent (and which had simply been shaken with sulphuric acid and then distilled), accidentally contained toluene. The facts that the product contained 14 atoms of carbon, and that its formation from heptylic chloride could be expressed by a simple equation, served to delay the discovery of the mistake.

On oxidation with dilute nitric acid the ketone yields a mixture of terephthalic and paratoluic acids, together with an oil—probably capronic acid. The sparingly soluble acid to which the composition $C_{13}H_{10}O_6$ was provisionally assigned, is therefore terephthalic acid, the previous analysis having given rather too much carbon and too little silver owing, doubtless, to the presence of small quantities of paratoluic acid, which would not be easily detected. When the oxime of the ketone is heated at 100° with sulphuric acid, it is converted into a crystalline substance melting at 78—79°, which is shown to be *heptylparatoluidine*, $C_6H_{13}\cdot CO\cdot NH\cdot C_6H_4\cdot CH_3$, by the fact that on hydrolysis with chlorhydric acid at 180°, it yields heptylic acid and paratoluidine.

127. "Oximidosulphonates or sulphazotates." By Edward Divers, F.R.S., and Tamemasa Haga.

Among the sulphazotised potassium salts discovered by Fremy are two named *neutral sulphazotate* and *basic sulphazotate*, the former of which Raschig has shown to be a hydroxylamine-disulphonate or oximidosulphonate.

Fully confirming Fremy's observations, that his two salts are directly convertible into one another, the authors hold them to be as certainly salts of one acid—oximidosulphonic acid—as are the alkali orthophosphate salts of one acid. Accordingly, oximidosulphonic acid is a tribasic acid, of which the three known potassium salts have the formulæ

$KON(SO_3K)_2$	$HON(SO_3K)_2$	$HON(SO_3K)_2,KON(SO_3K)_2$
Raschig's salt.	Fremy's neutral salt.	Fremy's basic salt.

The authors have obtained three sodium salts, $Na_3NS_2O_7$, $Na_2HNS_2O_7$, and $Na_2HNS_2O_7\cdot 2Na_3NS_2O_7$; the double salt of sodium not matching that of potassium. They have also prepared and analysed the barium salt, $Ba_3(NS_2O_7)_2$; the hydroxy-lead salt, $(HOPb)_3NS_2O_7$; and a great number of compound salts—of sodium and potassium and hydrogen with each other, and of these each with barium and with lead. They have also obtained strontium-sodium, strontium-potassium, calcium, and ammonium salts, besides compounds of dipotassium oximidosulphonate with potassium nitrate and with sodium chloride.

The neutral or two-thirds normal alkali salts, that is, dipotassium and disodium oximidosulphonates, are readily converted by hydrolysis into oxyamidosulphonate and sulphate; and the corresponding salts of copper, zinc, and other common metals are obtainable only in solution. These salts cannot be formed from the alkali salts, a fact observed by Fremy but discredited by Claus. For example, copper sulphate and dipotassium or disodium oximidosulphonate can be mixed in solution and then crystallised out separately by evaporation; but the formation of the copper and other salts in solution can be effected by interaction of their sulphates and lead or barium oximidosulphonate. Ammonium oximidosulphonates are also obtained from the lead or barium salt and ammonium carbonate.

Normal copper, manganese, zinc, and some other oximidosulphonates cannot exist, the attempt to form them resulting in the production of the two-thirds normal salt in solution and a precipitate of copper or other hydroxide; thus copper sulphate, added so long as it occasions a precipitate to the normal sodium salt, leaves disodium oximidosulphonate in solution along with sodium sulphate. Barium chloride and lead acetate, which yield normal salts, precipitate these from the five-sixths normal potassium salt, and leave the dipotassium salt in solution, from which, after a little evaporation, it crystallises. Such facts as these were observed by Fremy, but his results were not accepted by Claus. They form an interesting part of the evidence that the neutral and basic sulphazotates are salts of one and the same acid.

Oximidosulphonates, likely to become an important source of hydroxylamine (Raschig) and of hyponitrites, have hitherto been obtained by most unproductive and uncertain methods, Raschig's patented process to some extent excepted. Fremy states that he passed sulphur dioxide into a solution of potassium nitrite and hydroxide, but he did not supply the necessary details. Claus did not find the process productive, but the authors find it to be nearly perfect, giving easily and uniformily 95 and 97 per cent. of the calculated quantity, according as hydroxide or bicarbonate is employed. All that is essential is to pass sulphur dioxide into a solution containing potassium nitrite, and either potassium hydroxide or acid carbonate in single molecular proportions till lacmoid paper is reddened, keeping the mixture actively agitated and immersed in brine with ice floating in it. The mother-liquor is decanted, and the crystals drained dry.

The disodium salt is prepared in essentially the same way; but being exceedingly soluble, it has to be separated by evaporation. It, however, crystallises well, is an anhydrous salt, and can be preserved much better than the potassium salt. In consequence of its not falling out of solution during its preparation, some of it is destroyed by the sulphur dioxide, so that about one-tenth of the sodium nitrite gets converted into nitrilosulphonate. To allow for this, some sodium hydroxide or carbonate has to be used in excess of that indicated by the equation, $NaNO_2 + NaOH + 2SO_2$. Further, when the sulphur dioxide has been all passed in, the nitrilosulphonate has to be got rid of by hydrolysis into imidosulphonate, because its presence greatly endangers the existence of the oximidosulphonate.

The potassium oximidosulphonate, and also the sodium salt, but the latter only in very impure solution, may also be prepared by the action of metasulphites on nitrites. The potassium salt can, however, be quite easily prepared by this method from potassium nitrite, the yield being over 60 per cent. of the possible quantity. The only condition for such success, besides that of preserving a low temperature, is to take somewhat more than 3 mols. of potassium metasulphite to 2 mols. of potassium nitrite. The mixed solutions are to be left some time ice-cold, and the mother liquor of the resulting crystals then decanted whilst still ice-cold. The salt is contaminated with nitrilosulphonate, and must be washed and recrystallised.

To prepare a solution of the disodium salt, 1 mol. proportion of sodium nitrite is mixed with 2 mol. proportions of metasulphite. Much nitrilosulphonate and normal sulphite are formed at the same time, and from these the sodium oximidosulphonate cannot be separated.

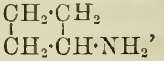
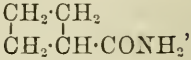
Alkali oximidosulphonates are all unstable, except in the absence of water. Those which are alkaline suffer partial reversion to nitrite and sulphite, and when by the interchange $2Na_3NS_2O_7 + H_2O = NaNO_2 + Na_2SO_3 + NaHSO_3 + Na_2HNS_2O_7$, the solution becomes acid, hydrolysis sets in and completes their decomposition. Those which are neutral or slightly acid to test paper soon undergo hydrolysis.

The fact of reversion of oximidosulphonate into nitrite and sulphite has until now escaped detection. This remarkable change is almost completed in presence of very concentrated solution of caustic potash, slowly in the cold, quickly on heating: $K_3NS_2O_7 + 2KOH = KNO_2 + 2K_2SO_3 + H_2O$.

Dry alkali oximidosulphonates, kept at temperatures a little over 100° in the air, slowly increase in weight by hydrolysing in atmospheric moisture.

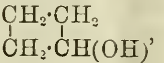
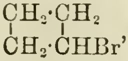
Oximidosulphonates decompose suddenly when heated: the normal sodium salt just above 180°, according to the equation: $2Na_3NS_3O_7 = 3Na_2SO_4 + SO_2 + N_2$; and the disodium salt at about 170°, partly in one way, partly in another, as shown by the equations: $2Na_2HNS_2O_7 = Na_2SO_4 + 2NaHSO_4 + SO_2 + N_2$; $8Na_2HNS_2O_7 = 3Na_2SO_4 + 5Na_2S_2O_7 + (NH_4)_2S_2O_7 + SO_2 + 3N_2$; while the normal hydroxy-lead salt suffers reversion into hydroxy-lead nitrite, lead sulphite, and water: $(HOPb)_3NS_2O_7 = (HOPb)NO_2 + 2PbSO_3 + H_2O$.

128. "Derivatives of tetramethylene." By W. H. Perkin, jun., F.R.S.

Some time since Freund and Gudeman (*Ber.*, **21**, 2692) endeavoured to obtain tetramethyleneamine,  $\begin{array}{l}CH_2\cdot CH_2\\ | \qquad\; | \\ CH_2\cdot CH\cdot NH_2\end{array}$, from the amide of tetramethylene-carboxylic acid,  $\begin{array}{l}CH_2\cdot CH_2\\ | \qquad\; | \\ CH_2\cdot CH\cdot CONH_2\end{array}$, by the action of bromine and potash, but without success.

The reason for their failure appears to lie in the fact that the amide used by them (m. p. 138°) was impure, as, if the pure substance recrystallised from ether and melting at 153° be employed, the action proceeds normally.

Tetramethyleneamine is a colourless oil (b. p. 82°), possessing a powerfully basic smell resembling that of amylamine; it mixes with water, heat being evolved, and absorbs carbon dioxide with avidity.

The *hydrochloride*, C_4H_9NHCl, crystallises from alcohol in long, prismatic needles, closely resembling ammonium chloride in appearance; the *platinichloride* $(C_4H_9NHCl)_2PtCl_4$, crystallises from water in glistening orange octahedra. The hydrochloride of tetramethyleneamine is converted by interaction with silver nitrite into *hydroxytetramethylene*,  $\begin{array}{l}CH_2\cdot CH_2\\ | \qquad\; | \\ CH_2\cdot CH(OH)\end{array}$, which is a colourless oil boiling at 123°. On digestion with fuming bromhydric acid, hydroxytetramethylene is converted into a heavy oil, readily separable into two substances boiling at 105° and 174° respectively. The former is *bromotetramethylene*,  $\begin{array}{l}CH_2\cdot CH_2\\ | \qquad\; | \\ CH_2\cdot CHBr\end{array}$, whilst the latter is a dibromobutane of the formula, $C_4H_8Br_2$, which, however, is not identical with any of the known isomerides.

This result appears to show that, as in the case of trimethylene, the tetramethylene ring may under certain conditions be split by hydrogen bromide. These experiments are being extended to other derivatives of tetramethylene in order to obtain some clue to the course of the action.

129. "β-2-Dimethylglutaric acid $(COOH\cdot CH_2\cdot C(CH_3)_2\cdot CH_2\cdot COOH$." By W. Goodwin and W. H. Perkin, jun., F.R.S.

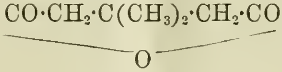
Dimethylacrylic acid $(CH_3)_2C{:}CH\cdot COOH$, is readily prepared by boiling methylic α-bromvalerianate, $(CH_3)_2\cdot CH\cdot CHBr\cdot CO_2CH_3$, with alcoholic potash (compare Duvillier, *A. ch.*, [5], **19**, 428); it crystallises from light petroleum in colourless needles which melt at 69°; when exposed to bromine vapour it is quantitatively converted into α-β-dibromvalerianic acid $(CH_3)_2{\cdot}CBr{\cdot}CHBr{\cdot}CO_2H$, which melts at 108—110°.

Ethylic dimethylacrylate, $(CH_3)_2{\cdot}C\colon CH{\cdot}COOC_2H_5$ (b.p. 155°), when digested in alcoholic solution with ethylic sodio-malonate is converted into ethylic dimethyl-propanetricarboxylate $EtCO_2{\cdot}CH\colon C(CH_3)_2 + CH_2(CO_2Et)_2 = CO_2Et{\cdot}CH_2{\cdot}C(CH_3)_2{\cdot}CH(CO_2Et)_2$.

This ethereal salt boils without decomposition at 203° (60 mm.), and on hydrolysis yields the corresponding dimethylpropanetricarboxylic acid, which crystallises from water in colourless prisms melting at 175°. At 200° this acid is readily decomposed evolving carbon dioxide, and forming β_2-dimethylglutaric acid,

$$COOH{\cdot}CH_2{\cdot}C(CH_3)_2{\cdot}CH(COOH)_2 = CO_2 + COOH{\cdot}CH_2{\cdot}C(CH_3)_2{\cdot}CH_2COOH.$$

This acid crystallises from water in plates, and melts at 100°; when digested with acetic anhydride it yields the anhydride



$$\underbrace{CO{\cdot}CH_2{\cdot}C(CH_3)_2{\cdot}CH_2{\cdot}CO}_{O},$$

which melts at 124°.

β_2-Dimethylglutaric acid, therefore, like camphoric acid, with which it is probably closely allied, yields an anhydride, which melts at a higher temperature than the corresponding acid; the investigation of the products of the condensation of ethylic dimethylacrylate with homologues of ethylic malonate is in progress.

130. "The products of the action of fused potash on camphoric acid."

By A. W. Crossley and W. H. Perkin, jun., F.R.S.

Several years ago Hlasiwetz and Grabowsky (*Annalen*, **145**, 205) studied the action of fused potash on camphoric acid, and stated that butyric acid, pimelic acid (isopropyl succinic acid), and an hydroxycamphoric acid, $C_{10}H_{16}O_5$, were obtained. As it seemed difficult to understand how butyric acid could be formed from camphoric acid, and as the authors were anxious to investigate the various hydroxycamphoric acids, they decided to carefully repeat these experiments.

They find that the fatty acids formed during the decomposition consist of large quantities of propionic acid and smaller quantities of at least four other fatty acids, among which are isobutyric acid, isovalerianic acid(?), and an acid of the formula $C_6H_{12}O_2$, boiling at 200°, which is probably isobutyl acetic acid, but no trace of butyric acid could be detected.

They have also failed to obtain any hydroxycamphoric acid, the acids of high boiling point which we produced consist of large quantities of pimelic acid, and small and varying quantities of unchanged camphoric acid.

It is hoped that the further investigation of this subject will give evidence of value in determining the constitution of camphoric acid.

131. "Conversion of ortho- into para-, and of para- into ortho-quinone derivatives. II. Dinaphthyldiquinone." By S. C. Hooker and J. G. Walsh, jun.

The authors have re-examined the supposed β-dihydroxydinaphthyldiquinone, which Kern (*Ber.* **17**, 3019) obtained by oxidising the $\alpha\alpha$-dinaphthyldi-β-quinone discovered by Stenhouse and Groves. According to Kern, the product which is formed on exposing an alkaline solution of the quinone to the air is pale yellow; as, however, one of the authors had previously found that when β-naphthaquinone derivatives gave *pale* yellow products, still possessed of quinonoid properties, the change in colour involved a change of the β- into the α-naphthaquinone derivative, as it was improbable that an $\alpha\alpha$-dinaphthyldi-β-quinone could yield an α-dihydroxy-derivative, it appeared desirable to repeat Kern's experiments. The result has been the discovery that Kern's product is nothing more than the well-known β-hydroxy-α-naphthaquinone. The yield, however, is small, the larger portion of the diquinone being converted into a colourless compound or compounds soluble in water.

March 22nd, 1894. Anniversary Meeting. Dr. Armstrong, President, in the Chair.

The President delivered an address, giving expression to the views that he had been led to form during his long official connection with the Society, and claiming for it the right to exercise far wider functions in the future on the ground that, although named the Chemical Society of *London*, it now may be regarded as the embodiment of the interests of chemical science in the United Kingdom.

Before presenting the Longstaff Medal, he referred to Dr. Longstaff's death in the interval since the last award of the medal, and to the lively interest which the founder of the Research Fund took in our affairs up to the very last; also to Mr. Mond's donation of £100 to the fund during the year; and to the income of the fund and the importance of securing further contributions. In presenting the medal to Mr. Horace T. Brown, F.R.S., the President referred to his early career and the importance of the services he had rendered to chemical science, not only directly but also indirectly, by introducing scientific practices into the brewing industry.

The following statistics were referred to :—

Number of Fellows, March, 1893		1895
Since elected who have paid their fees		140
		2035
Removed on account of non-payment of fees	33	
Withdrawn	22	
Deceased	19	
		74
Present number of Fellows		1961
Number of Foreign Members		33

The following Fellows have died within the year :—J. T. Brown, J. H. Bicket, Dr. James Blake, Russell Carew, Col. F. C. H. Clarke, R. H. Davies, William Foster, Samuel Gale, C. H. Heaton, H. R. Hind, Hodgson Jones, Dr. A. Leibius, S. A. Phillips, H. D. Pochin, Charles K. Scott, W. B. Tustin, H. B. Thornton, John Tyndall, F.R.S., and John Woodland.

The following Fellows have withdrawn from the Society :—Harold Alger, Dr. E. J. Ball, J. B. Barlow, Thomas Beesley, F. W. Boam, George Collar, Dr. T. Cooksey, J. H. Dagger, Rev. G. Daubeney, Clement Higgins, Walter Hogben, U. A. Jackson, J. F. McArthur, J. C. Mulrean, G. Gordon Parker, Henry Piele, H. Pilkington, T. W. Shore, A. J. Smith, Rev. C. J. Taylor, A. Trobridge, and A. Wingham.

The names of the following Fellows have been removed from the register, having ceased to be Fellows owing to non-payment of the subscription :—Dr. L. Bernstein, T. F. Barbour, P. C. Bunn, R. G. Christopher, Adolph Dresel, A. C. Diogo, R. S. Edwards, G. W. Gibson, T. A. Hedley, Rev. H. Heap, A. C. Holborn, A. H. Jackson, J. C. Jackson, A. H. Knight, F. T. Knott, T. H. Leeming, Dr. C. Morfit, J. L. MacMillan, Dr. W. Mackey, W. E. Matthews, Frank Mousley, W. B. Nesbit, W. S. Newman, T. A. Pooley, G. L. Rait, A. P. Smith, J. Snodgrass, R. St. Stephens, P. Y. Sheshadri, F. W. Shaw, James Sibun, H. K. Tompkins, and E. W. Whieldon.

The Society has lost one of its foreign members, Edmond Fremy, who died early in March.

Although the increase in the number of Fellows during the year is satisfactory, and the number large, when it is considered how wide are the applications of chemical science, and that the aid of the chemist must ere long be recognised as essential to the prosperity of a majority of industries, the Society should be able to count on a far larger measure of support in the future—certainly every member of the Society of Chemical Industry should belong to it, and many pharmacists. Discussing the question of qualification for the fellowship, the President expressed the opinion that it would probably be advantageous to remove the word "qualification" from the certificate, and to adopt a principle of absolute free trade, such as prevails in the sister society in Berlin, with the object of interesting as many as possible in the work of the Society.

The misuse of the letters F.C.S. was adverted to.

The Society's publications were next considered. The 1893 volume of Transactions contains no fewer than 104 papers, occupying 1,432 pages, that published in the previous year having contained only 90 papers, occupying 1,096 pages. Of the two volumes of Abstracts published in 1893, the organic section contains 1,228 notices, occupying 744 pages; whilst the general section contains 1,418 abstracts, occupying 612 pages. The index to the Transactions, Abstracts, and Proceedings occupies no fewer than 158 pages. Compared with those of the previous year, these statistics indicate that 296 more papers have been abstracted, although from the more concise style of abstracting adopted, the abstracts are contained in 180 fewer pages. The number of communications made to the Society during the session has been 131.

After pointing out that chemical literature is fast becoming unmanageable and uncontrollable from its very vastness, the President proceeded to argue that it would be of great advantage to centralise the publication of chemical papers as far as possible, and that there should be one journal for each country. No fewer than 2,500 copies of the Society's journal went into circulation, and the Society had now so thoroughly established its position, and was so far reaching in its organisation, that it had a right to expect—indeed demand—the support of British chemists generally. It must be to the advantage not only of English speaking chemists, but of chemists throughout the world, that such support should be accorded to it.

Having discussed this subject at length, and the relation of the Society to other bodies, including the Royal Societies of London and Edinburgh, the attitude of authors communicating their papers elsewhere was commented on, and the necessity of consolidating the interests of chemists in this country in order that their work may be treated with the respect it deserves was emphasised.

The importance of action being taken by the Society of Chemical Industry to focus all information relating to applications of chemical science to industry was then referred to; and also the desirability of steps being taken to organise a system of publishing physical papers and abstracts, the hope being expressed that the Physical Society of London would soon undertake this work.

The necessity of greater care being taken by authors in the preparation of their papers next came under discussion, greater conciseness being advocated, as well as more attention to literary style.

The abstracts of papers published elsewhere were referred to as very satisfactory on the whole, although they could not be regarded as by any means a complete presentment of the work that was being done. The necessity of occasionally monographing the state of knowledge with regard to various special fields of work was referred to, and the hope expressed that before long arrangements would be made to place such accounts in the hands of the Fellows.

The character of the Proceedings was then considered, and the opinion expressed that this should be in every way an official publication, entirely under the control of its recognised official editors.

The additions to the library having been noted, reference was made to the near approach of the time when the shelf room would be exhausted. The probable insufficiency at no distant date of the accommodation afforded by the meeting room was also commented on. The expectations that the structural alterations made during the previous year and the introduction of the electric light would greatly conduce to the comfort of those attending the meetings has been fully confirmed during the session. The objects to be secured by the meetings were next considered.

The publication of the Stas and Kopp memorial lectures was noted. The delivery of addresses in memory of von Hofmann having been commented on, reference was made to Dr. Caro's monograph giving the history of the development of the coal tar colour industry, in which von Hofmann's influence was very fully taken into account, and to the lessons to be learnt from the contemplation of von Hofmann's career.

Referring next to the events of the year which are of interest to chemists, mention is first made of the Rothamstead jubilee, and to the public recognition of Dr. Gilbert's great services which it had involved.

The equipment of a laboratory for its examinations by the Institute of Chemistry is spoken of as a step which cannot fail to have most important results, and which may be said to have established the Institute on a firm basis. The inestimable value of a broad training such as is now demanded of candidates by the scheme introduced by the late President, Prof. Tilden, is also referred to.

Other topics dwelt on are the establishment of a research department in connection with the Imperial Institute charged with the examination and exploitation of the innumerable natural products from India and the Colonies collected together at the Institute; the establishment in London of the Institute of Preventive Medicine; and the appointment of inspectors by the Science and Art Department, whose duty it will be to take cognisance of the manner in which teaching is being carried on and to advise the teachers.

The action taken by the Royal Society of London in issuing a circular to the scientific world suggesting that from the beginning of the coming century complete authors and subject catalogues of science should be prepared by *international co-operation* is next brought under notice, and the importance of making any future index of chemical work a classified index is dwelt on. Lastly, reference is made to the report relating to the establishment of a teaching university in London and to the appointment of the Commission on Secondary Education.

He had always thought, said the President, that it should be the duty of the occupant of the chair to deliver an address on a chemical subject, and he had been surprised to find how uniformly previous Presidents had refrained from so doing: he now realised, however, how difficult it was to avoid political subjects and how easy therefore to avoid scientific subjects. There are, however, a multitude of scientific questions the discussion of which at the present time would be of great interest, such as—to mention but a few—the relation of physical properties to structure, and the properties of elements such as nitrogen, and, indeed, elements generally, as dependent on the structure of the molecules in which they are contained; or the fundamental principles on which structural formula generally are based, including the discussion of von Baeyer's very remarkable experimental investigations of benzene derivatives; or the laws of substitution; or valency; or alloisomerism; or bacteriology and its general bearings on the question as to the nature of the chemical changes attendant on life; including the discussion of the supposed assimilation of nitrogen by plants; or, lastly, the general bearings of the highly specialised observations which constitute the work of the day; on each of which subjects a lengthy essay might be written if only time and space were at disposal. The interdependence of chemical and electrolytic change being a subject which has given rise to so much discussion, and being of such fundamental importance at the present time, he is led to devote some space at the close of the address to a consideration of this subject more in detail.

Sir Frederick Abel proposed a vote of thanks to the President coupled with the request that he would allow his Address to be printed. This was seconded by Dr. Russell, and carried unanimously.

The Treasurer then gave an account of the Society's income and expenditure during the past session. The receipts by admission fees and subscriptions had been £3,887 6*s.* 8*d.*, as against £3,771 11*s.* 4*d.* in the previous year; £424 11*s.* 6*d.* had been realised by the sale of the Journal, practically the same amount as in the previous year. The year's dividends amounted to £367 2*s.* 7*d.*, and the balance at the bank was £1,842 1*s.* 10*d.*, as against £1,511 17*s.* 1*d.* in the previous year. The Journal had cost £2,882 17*s.* 3*d.*, instead of £2,745 7*s.* 4*d.*; the expenditure on the library amounted to £497 0*s.* 9*d.*; the Proceedings cost £215 16*s.* 5*d.*; the total expenditure being £4,395 8*s.* 3*d.* Grants amounting to £185 had been made from the Research Fund.

Mr. Warington proposed, and Mr. Pickering seconded, a vote of thanks to the Treasurer, which was carried. Professor Thorpe, after replying, proposed a vote of thanks to the Auditors; this was seconded by Mr. Page and carried.

A vote of thanks to the office bearers and Council was proposed by Dr. Stevenson, seconded by Dr. Messel, and carried. Professor Thomson replied.

Mr. Horace T. Brown proposed, and Dr. J. A. Voelcker seconded, a vote of thanks to the Editors, Abstractors, and Librarian. Mr. Groves replied.

A ballot was then taken, when the following were declared by the scrutators elected as Officers and Council for the ensuing session:—

President: H. E. Armstrong, LL.D., Ph.D., F.R.S.

Vice-Presidents who have filled the office of President: Sir F. A. Abel, Bart., K.C.B., D.C.L., F.R.S.; A. Crum Brown, M.D., F.R.S.; W. Crookes, F.R.S.; E. Frankland, D.C.L., F.R.S.; Sir J. H. Gilbert, Ph.D., F.R.S.; J. H. Gladstone, Ph.D., F.R.S.; H. Müller, Ph.D., F.R.S.; W. Odling, M.B., F.R.S.; W. H. Perkin, LL.D., Ph.D., F.R.S.; Lord Playfair, Ph.D., K.C.B., F.R.S.; Sir H. E. Roscoe, LL.D., F.R.S.; W. J. Russell, Ph.D., F.R.S.; A. W. Williamson, LL.D., F.R.S.

Vice-Presidents: E. Atkinson, Ph.D.; Horace T. Brown, F.R.S.; A. Vernon Harcourt, M.A., F.R.S.; Ludwig Mond, F.R.S.; C. O'Sullivan, F.R.S.; William Ramsay, F.R.S.

Secretaries: Wyndham Dunstan, M.A., F.R.S.; J. Millar Thomson.

Foreign Secretary: Raphael Meldola, F.R.S.

Treasurer: T. E. Thorpe, B.Sc., F.R.S.

Ordinary Members of Council: Charles F. Cross, B.Sc.; Harold Dixon, M.A., F.R.S.; Bernard Dyer, D.Sc.; R. J. Friswell; A. G. Green; F. Stanley Kipping, D.Sc.; W. H. Perkin, jun., F.R.S.; W. A. Shenstone; Thomas Stevenson, M.D.; John A. Voelcker, Ph.D.; W. P. Wynne, D.Sc.; Sydney Young, D.Sc., F.R.S.

At the meeting of the Society on Thursday, April 19th, at 8 P.M., the following papers will be read:—

"The magnetic rotations of haloid derivatives of fatty acids, and of acetic and propionic acids, phosgene, and ethylic chlorocarbonate." By Dr. W. H. Perkin, F.R.S.

"The action of metals on strong acids." By Messrs. G. J. Burch and J. W. Dodgson.

"The action of light on oxalic acid." By Dr. A. Richardson.

"English Jute Fibre." II. By A. Pears, Jun.

"Natural Oxycelluloses." By C. Smith.

CERTIFICATES OF CANDIDATES FOR ELECTION AT THE NEXT BALLOT.

May 3rd, 1894.

N.B.—The names of those who sign from "General Knowledge" are printed in *italics*.

Alhusen, F. E.,

Jesus College, Cambridge.

First Class Natural Sciences Tripos, Parts I and II. Published, in conjunction with Dr. Ruhemann, a paper on "Formation of Pyrrol Derivatives," and continual research work.

M. M. Pattison Muir. S. Ruhemann.
A Hutchinson. J. T. Hewitt.
A. Sheridan Lea. C. T. Heycock.
F. H. Neville.

Ashcroft, Joseph Beynon,

96, Warner Street, Derby.

Schoolmaster. Studied for several years in the Evening Classes of the Manchester School Board. Four years' Teacher of Chemistry at Cheadle Science School, Cheshire; one year Teacher of Chemistry, Derby School of Science. Student. Studied for two years at University College, Nottingham, in the Chemical Laboratory. Passed Inter. B.Sc., London University.

Frank Clowes. J. Bernard Coleman.
R. Lloyd Whiteley. R. L. Taylor.
Frank T. Addyman. *M. J. R. Dunstan.*

Asher-Aron, Samuel Bernard,

P.O. Box, 1021, Johannesburg.

Metallurgical Chemist. Associate of the Royal School of Mines (1890—92). One of the Abstractors for the *Journal of the Chemical Society*. Late Assayer to the Wemmer Gold Mining Company. At present Chemist to the Ferreira Gold Mining Company.

T. E. Thorpe. Chapman Jones.
Charles E. Groves. Watson Smith.
William Tate.

Ashdown, Charles Henry,

"Belmont," St. Albans, Herts.

Science Teacher. Science Master, King Edward VI Grammar School, St. Albans, seven years. Lecturer in Chemistry under Hertfordshire C.C. to Head Teachers of Elementary Schools. Chemistry Demonstrator, St. Alban's School of Science and Art; Science Teacher, South Kensington. Studied Chemistry, King's College, London.

John Attfield. G. Stillingfleet Johnson.
Harry M. Freear. *R. Meldola.*
J. Henry Gilbert.

Bowes, Harry,

9, Union Terrace, Cheetham Hill, M/C.

Analytical Chemist. I was educated at the Manchester Grammar School, where I passed through courses of Classics, Modern Languages, and Mathematics. I commenced the study of Chemistry in 1883, under Mr. Francis Jones, F.I.C., &c.. and also, at the same time, studied Physics under Mr. John Angell, F.I.C., &c. In January, 1887, I entered the laboratory of Messrs. Crace-Calvert and Thomson, of Manchester, as articled pupil; after three years I became Junior Assistant, and for the last three years have held the position of Principal Assistant, which I continue to hold. I have had experience in nearly all branches of analytical work, and have been engaged in many researches connected with the arts and manufactures.

William Thomson. J. Carter Bell.
C. Estcourt. Francis Jones.
John Angell. M. W. Jones.
Otto Hehner. *Alfred H. Allen.*
Charles E. Cassal.

Buttemer, Robert William,

St. Mary's, Godalming.

Graduate of Emmanuel College, Cambridge. Natural Sciences Tripos, 1893, Part I, Class II, Chemistry chief subject. Private laboratory; interested in research. Assistant in Agricultural Chemical work for the Surrey County Council.

John Percival. Sidney Skinner.
F. H. Neville. *C. T. Heycock.*
W. B. Bottomley.

Chambers, Thomas,

Dudley House, Coatbridge, N.B.

Chemist. Three years' study Yorkshire College, Leeds. One year

Chemist, New Explosives Company, Stowmarket. One and half years' study with Professor Mills, Glasgow. Associate of the Institute of Chemistry.

Edmund J. Mills.	Arthur Smithells.
Julius B. Cohen.	Herbert Ingle.
Aug. Schloesser.	G. G. Henderson.

Gabb, George Hugh,
91, Elgin Avenue, W.

Analyst and Consulting Chemist. Late Assistant to A. W. Stokes (Paddington Vestry Hall). Associate of Society of Public Analysts. Now, and for the past two years, Resident Analyst to Messrs. Welford and Sons, Limited.

Alfred W. Stokes.	Harald Faber.
C. R. Alder Wright.	*J. W. Swan.*

H. Wilson Hake.

Golden, Arthur Robert, B.A. (Lond.),
17, Trinity Street, Norwich.

Headmaster, Higher Grade School, Norwich. Headmaster of Organised Science School; Lecturer on Chemistry, Inorganic and Organic, Theoretical and Practical, Volumetric and Gravimetric Analysis; Qualified Teacher in Chemistry by the Science and Art Department; B.A., London.

Francis Sutton.	Hy. Austin Appleton.
R. S. Cahill.	Edward J. Caley.
W. H. Corfield.	*F. Napier Sutton.*

Hewitt, Oswald Ernest William,
116, Burnt Ash Hill, Lee, S.E.

Agricultural Analytical Chemist. For five years Chief Assistant to Mr. F. J. Lloyd, 4, Lombard Court, E.C., and have carried out research work in cheese-making for the Bath and West of England Agricultural Society for different periods during the last three years, and also in cider-making this year (1893).

Fredk. J. Lloyd.	Thos. Stevenson.
R. Bodmer.	*R. Warrington.*

Frank L. Teed.

Jackman, Edwin James,
152, Upton Lane, Forest Gate, E.

At present employed in the Chemical and Gas Department of the London County Council. During the past eight years student in Chemistry, Mathematics, and Physical Sciences at the City of

London College and the City and Guilds Technical College (Electricity); holding many Science and Art Department Certificates, including a First Class Honours in Practical Inorganic Chemistry. A Member of the Society of Chemical Industry.

Isaac S. Scarf.
R. Grimwood.
F. S. Adair Roberts.
C. C. Hutchinson.
Thos. Tyrer
W. J. Dibdin.
Wm. Jno. Livingston.
L. W. Fulcher.
Saml. H. Johnson.
A. Brake.
Charles E. Sohn.

Kellas, Alex. Mitchell,

24, Cecile Park, Crouch Hill, London, N.

Assistant in Chemical Department, University College, London; B.Sc. (Lond.).

William Ramsay.
James Walker.
J. Norman Collie.
R. T. Plimpton.
John Shields.

Knight, William Albert,

Sexey's Trade School, Bruton, Somerset.

Headmaster of Public Secondary School. Teacher's Certificate (1st Division) from Education Department. Student at St. John's College, Battersea, for two years. First Class Teacher's Certificate in Chemistry and First Class Honours and Medal in Agriculture from the Science and Art Department. London University, Matriculation (18th in Honours), Inter. B.A. (1st Class). Five years' teaching of Chemistry.

Wm. B. Hards.
F. W. De Velling.
Joe Frost.
F. W. Westaway.
Lewis S. Cocking.
Fredk. J. Lloyd.

Mansell, James, B.A. (Lond.),

49, Upper Tichborne Street, Leicester.

Senior Science Master, Wyggeston Boys' School. Lecturer in Chemistry, Leicester Technical School. Have worked in the King's College Laboratory, London, and in the University College Laboratory, Nottingham. Have been Senior Science Master in the Wyggeston Boys' School for four years, where I am teaching Theoretical and Practical Chemistry to over 250 boys. Lecturer in the Leicester Technical School in Organic and Inorganic Chemistry for three years.

G. Stillingfleet Johnson.
Reginal B. Brown.
H. J. H. Fenton.
H. N. B. Richardson, B.A.
R. E. S. Richardson.

McMullan, Charles,

Holywood, Co. Down; and 20, Corn Market, Belfast.

Chemist and Manager of Soap Works. I have worked as a Student for three years under Professor W. N. Hartley, Royal College of Science, Dublin, and during that time went through a complete course of Analytical and Manufacturing Chemistry. I have also passed the Institute of Chemistry examination, in December, 1893, and have been elected an Associate of same.

W. N. Hartley. Thos. A. Shegog.
Thomas Byrne. Hugh Ramage.
W. E. Adeney.

Parker, Matthew A.,

13, Hamilton Crescent, Partick, Glasgow.

Private Assistant to Dr. Henderson. Professor of Chemistry. The Technical College, Glasgow. I hold the degree of Bachelor of Science of Glasgow University, having specialised in Chemistry. For the past six years I have made a special study of Chemistry. first at the University, and latterly at the Technical College, where I am at present engaged in research work, under Dr. Henderson.

John Ferguson. G. G. Henderson.
J. T. Bottomley. A. Humbolt Sexton.
James Robson. Aug. Schloesser.
Thomas Gray.

Roberts, Thomas John,

31, North Road, St. Helen's, Lancashire.

Science Teacher. Student at the College of Chemistry, Liverpool, two and a-half years. Student at the University College of Aberystwith, one year. Student at the University College of Bangor, one year. Assistant Science Master at the Shipley Technical Schools.

George Tate. James J. Dobbie.
George McGowan. Arthur W. Warrington.
H. Lloyd Snape.

Stoddart, Fredk. Wallis,

Grafton Lodge, Sneyd Park, Bristol.

Analytical Chemist. Public Analyst for Bristol, &c. Lecturer on Hygienic Chemistry and Bacteriology at Bristol Medical School.

Sydney Young. Arthur Richardson.
W. A. Shenstone. William A. Tilden.
Otto Hehner.

Swinburne, James,

4, Hatherley Road, Kew Gardens.

Electrical Engineer and Electrometallurgical Chemist. Worked for some time at Chemistry of Secondary Batteries. Has given special attention to Applications of Electricity to Chemical Manufacture. Author of paper on Secondary Batteries, Inst. Elect. Eng. Author of paper on Electrolysis Phys. Soc. Have given "Tyndall Lectures" on Applications of Electricity to Chemistry, at R. Institution; also papers on Incandescent Lamps, and on Chemistry of Standard Cells; also paper on Commercial Electrolysis, Inst. Elect. Eng.

William Crookes. J. H. Gladstone.
John Pattinson. John M. Thomson.
Wyndham. R. Dunstan.

Terry, Edwin,

41, Nightingale Lane, Balham, S.W.

Analytical Chemist. Fellow of the Royal Microscopical Society, 1882. Student in the Laboratories of the Pharmaceutical Society, two years. Assistant to Professor Attfield, F.R.S., 1½ years, 1886—7. Analyst to Messrs. Burgoyne and Co., 1887—94. Analyst to Messrs. Credlan, Hart and Co., Dairy Farmers.

John Attfield. M. Carteighe.
Wyndham R. Dunstan. Thos. Farries.
T. Pitt. John A. R. Newlands.
B. E. R. Newlands.

Wheeler, Henry L., Ph.D.,

1812, Priory Aven., Chicago, U.S.A.

Chemist. For the past six years student of Chemistry at Sheffield Scientific School of Yale University. Graduated Ph.B. in 1890; Ph.D. in 1893. Member of Berlin Chemical Society. Member of Munich Chemical Society.

Professor von Baeyer. William Frew.
John S. Lumsden. *Arthur Smithells.*
Herbert Ingle. *Charles Frederic Baker.*

The following Candidates are recommended by the Council for ballot under Bye-law I (para. 3):—

Hirsch, Charles T. W.,

Fiji Islands; address, Dr. C. Hirst, Post Office, Suva, Fiji Islands.

Government Medical Officer. Is studying the Properties and Actions of various Poisonous Drugs in Use in Fiji, and is anxious to have the Society's Journal.

Frederic Jas. M. Page.

Kelly, John Abraham, L.R.C.P. and S. (Edin.), L.F.P. and S. (Glas.), L.M.S. Madras University,
Hyderabad Deccan.

Assistant to the Residency Surgeon, Hyderabad. Teacher of Physics and Chemistry in the Hyderabad Medical School, and Lecturer in Medical Jurisprudence and Toxicology. Has been engaged in analytical work for medico-legal purposes for the past eight years.

J. L. Van Geyzel. Thomas Stephenson.
H. R. Hayles.

HARRISON AND SONS, PRINTERS IN ORDINARY TO HER MAJESTY, ST. MARTIN'S LANE.

Issued 2/5/1894.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

No. 137. Session 1893–94.

April 19th, 1894. Dr. H. E. Armstrong, President, in the Chair.

Messrs. W. Lloyd Williams, R. Curling Styles, and J. Cardwell Quinn were formally admitted Fellows of the Society.

Certificates in favour of the following candidates were read for the first time:—George Donald, Arnold Print Works, North Adams, Mass. U.S.; Robert John Flintoff-Haxby, Crumpsall Lane, Crumpsall, Manchester; Sydney Walters Harris, 15, Lansdowne Terrace, Walters Road, Swansea; J. H. Hickens, North Devon Lodge, Cheltenham; Wilmot Holt, Jun., The Park, Didsbury, Manchester; Arthur Peach Hope, Salisbury Road, Leicester; James McLeod, 2, Gladstone Terrace, Paisley; E. Brooke Pike, 6, Lathom Road, East Ham; Herbert Stephen Shorthouse, 47, Pershore Road, Birmingham; Ernest Alfred Smith, 17, Oval Road, Regent's Park, N.W.; Herbert W. Steel, Wedderburn, Paisley; Edward B. Shuttleworth, Trinity Medical College, Toronto; George Dupré Thudichum, Montrose, Dorset Road, Merton Park; Robert Wright, 11, Eagle Parade, Buxton.

Of the following papers those marked * were read:—

*132. "The magnetic rotations of derivatives of fatty acids containing halogens; of acetic and propionic acids, phosgene, and ethylic carbonate." By **W. H. Perkin, Ph.D., F.R.S.**

The first subject considered in the paper is the magnetic rotation of acetic and propionic acids in reference to their molecular complexity. From the determinations made at widely different temperatures it is considered that the kind of association of molecules referred to by Ramsay and Shields does not influence the results. In the cases of phosgene, ethylic chloroformate, and ethylic carbonate it is shown that the two chlorine atoms in phosgene behave as if they had two different values; that in such derivatives as ethylic chloroformate, for example, having the smaller value. On comparing this compound with phosgene and ethylic carbonate, it would appear that the two ethoxyl groups in this latter substance which displace the two chlorine atoms in phosgene, also have two separate values. The next section relates to the chloro- and bromo-derivatives of acetic acid and its ethereal salts. With respect to the acids it is found that alone or in aqueous solution they yield practically the same numbers. The effect of etherification on these acids, however, is found to be anomalous. Instead of changing in rotation by the same amount as in the case of acetic acid and its ethereal salts, the values for ethyl and methyl increase as the number of halogen atoms introduced. There is one exception, viz., dibromacetic acid. The alteration of the rotation of acetic acid and its ethereal salts by the introduction of chlorine is then considered. It is shown that differences corresponding to successive displacements in the case of chlorine do not follow a regular order; but, with bromine, they generally increase with the displacements, and the fluctuations are shown to be similar in character to those exhibited by chlorine and bromine derivatives of methane. Ethylic iodoacetate was found to give lower results for iodine than propyl iodide. The rotation of ethylic α-chloro-propionate furnishes a value for chlorine similar to that in ethylic dichloracetate. Ethylic trichlorlactate gives an average value for chlorine somewhat lower than that of ethylic trichloracetate.

The measurements of α-bromopropionic acid and butyric acids and their ethereal salts furnished the usual rotations for members of a homologous series for the same difference of composition; the usual value being obtained for a difference of CH_2, and also for bromine. In the acids, however, the value is apparently smaller than in the ethereal salts, as these, like the acetic compounds, are changed by etherification more than the compounds not containing halogens.

The difference in the values obtained for the chlorine and bromine compounds are then considered, and suggestions are made as to special circumstances which may influence the magnetic rotation.

Discussion.

The President remarked that Dr. Perkin's results afforded further evidence of the remarkable influence of *several* halogen atoms to which Thomsen had first specially called attention in his thermochemical researches. The very noteworthy difference between the magnetic constants of the chlorinated and brominated acids to which Dr. Perkin drew attention, which was correlated with an equally striking difference manifest on comparing the boiling points, served to suggest that the method of reducing the results was scarcely such as to bring out the true magnetic constants.

Dr. GLADSTONE commented on the irregularities in the values obtained for the chloro-derivatives of acetic acid as compared with the corresponding bromo-derivatives.

Mr. RODGER supported the President's statement that the character of Dr. Perkin's results no doubt depended to some extent on the mode of treating the experimentally observed quantities. In measurements where the wave-length of the light and the strength of the magnetic field remained the same throughout, the difficulty lay in obtaining a measure of the molecular rotation in which the influence of temperature on the rotatory power was either eliminated or allowed for. Dr. Perkin employed the ratio $\alpha M/d$ as determined for the substance to the corresponding quantity in the case of water as the value of the molecular rotation. This ratio would only be independent of the temperature if α/d were the same function of the temperature for water and for the substance. The early experiments of De la Rive, Dr. Perkin's own results, as well as observations as yet unpublished by Mr. Watson and the speaker, have shown that this is not the case.

Recently, Guye has proposed the expression $\alpha\sqrt[3]{M/d}$ instead of $\alpha M/d$ as a more probable measure of the molecular rotation. At first sight (compare Proc., 1893, p. 236) this new expression appears to be the more satisfactory. It may be shown, however, that it can only give the correct measure of the molecular rotation if it is assumed that the medium consists of elementary cubes at the centre of each of which is a molecule, and the volume of each of which is proportional to the molecular volume. We should then regard each cube as representing the sphere of activity of the molecule, and consider that the total effect of the medium depends solely on the number of cubes which the ray traverses. Whichever measure be adopted, experiment shows that neither eliminates the effect of temperature, neither α/d nor $\alpha/\sqrt[3]{d}$ is constant; hence satisfactory conclusions can only be arrived at when the effect of temperature on magnetic rotation has been more fully studied and values of the molecular rotation have been measured at comparable temperatures.

In the communication under discussion, Dr. Perkin has furnished extensive support to the conclusion that the effect on a physical property brought about by replacing an atom of hydrogen in a methyl group by an atom of halogen varies according as it is the first, second or third halogen atom which is thus united to the carbon atom. In their paper on viscosity (shortly to appear in the *Phil. Trans.*), Professor Thorpe and the speaker pointed out that in the case of viscosity, surface-energy, boiling point, and critical temperature, the change produced on replacing the first hydrogen atom was the greatest, and that on replacing the third hydrogen atom the smallest; whereas, in the case of molecular volume and molecular refraction, the reverse rule appeared to hold. The properties in the first group depend mainly on effects in play between molecules; the last two properties, on the other hand, are mainly the result of influences resident within the molecules. The sense in which the effect of substitution changed thus appeared to be correlated with the nature of the property dealt with. Dr. Perkin's present results show, however, that in the case of the same property the substitution effect may vary in both senses, or the variation may even be irregular. Whether this result as well as the other anomalies observed by Dr. Perkin are due to the fact that the effect of temperature is not allowed for, or whether it is also due to the fact that the molecular complexity of some of the liquids examined influences the results, can only be decided when more is known regarding the mode in which the molecular rotation should be calculated, and when the effect of change of density has been more fully investigated.

Dr. Perkin remarked that the effect of temperature on magnetic rotations, to which he had often drawn attention, is usually small with fatty compounds, although more considerable in the aromatic series.

In closing the discussion, the President added that the impression he had gained from Dr. Perkin's figures was that in order to take into account the diverse nature of the chlorinated and brominated acids, it was probably necessary to introduce a term into the calculation which would give expression to the fact that whereas there was a great difference in boiling point between the di- and tri-bromo-derivatives, there was but a slight one between the corresponding chlorinated compounds.

*133. "The action of concentrated acids on certain metals when in contact with each other." By George J. Burch, M.A., and J. W. Dodgson.

In 1790, James Keir (*Phil. Trans.*, 1790, p. 367) announced that a mixture of strong nitric and sulphuric acids could be used for stripping the silver from old-plated copper goods. The authors have investigated the chemical and electrical phenomena of this and other reactions of the same type, and now present a preliminary account of their work.

Experiments with a Silver-copper Couple.—A sheet of "pure" silver was cut into strips, which were scraped bright, bent into a U-shape, and weighed. To each was fitted a similar strip of copper, carefully cleaned and weighed, the whole forming an elliptical ring, held together by the elasticity of the metals. A number of test-tubes arranged in a water bath contained the mixed acids diluted with various proportions of water. Each ring remained under the surface for 47 minutes, and was then rapidly removed, wiped, washed, and weighed. The liquid was not stirred during the experiment.

Silver-Copper Couple, in a Mixture of 1 *part Nitric Acid of rel. dens.* 1·436 *with* 5 *parts* H_2SO_4 *of rel. dens.* 1·84 *with various proportions of Water ranging from* 1 *to* 10 *molecules per molecule of* H_2SO_4. *Temperature* 20° C.

Molecular proportions of water.	Silver.			Copper.		
	Taken.	Loss.	Loss.	Per unit area.	Loss.	Taken.
None added	0·7710	0·0426	0·01075	0·00027	0·0013	1·3265
1	0·7000	0·0358	0·00994	0·00061	0·0027	1·2082
2	0·7114	0·0234	0·00616	0·00038	0·0018	1·1320
3	0·7284	0·0251	0·00633	0·00075	0·0036	1·3252
4	0·7395	0·0170	0·00523	0·00250	0·0100	1·1954
5	0·7052	0·0052	0·00144	0·00288	0·0127	1·2209
6	0·7505	0·0110	0·00399	0·01792	0·0717	1·2671
7	0·7290	0·0176	0·00463	0·03475	0·1526	0·9775
8	0·7033	0·0343	0·00866	0·05116	0·2456	1·3216
9	0·6957	0·0268	0·00827	0·05302	0·2129	1·1854
10	0·6342	0·0300	0·00833	0·05895	0·2594	1·2055

In the stronger solutions, a yellowish-white powder separates from the silver, and a clear, heavy liquid of strong refracting power streams from it. Little or no gas is evolved.

During a few seconds after immersion the copper is covered with a white froth. This clears away, and the surface remains bright. Probably, nearly all the loss of copper occurs at this stage. The liquid becomes of a pale greenish-yellow colour, and a good deal of an almost white powder is deposited. A blue tint only appears when six or more molecular proportions of water are present to one of sulphuric acid. When the dilution is represented by $8H_2O + H_2SO_4$, nitrous fumes first begin to appear. It will be observed that the amount of silver dissolved is least with $5H_2O$, after which it increases again, and that the copper, which is practically untouched at $3H_2O$, is now rapidly attacked. At temperatures above 50° C. the results are somewhat different.

Magnesium-Silver Couple.—In a mixture of 10 parts sulphuric acid of rel. dens. 1·84 with 1 part nitric acid of sp. gr. 1·436, the magnesium retained its brilliant appearance during an hour and 20 minutes, while the silver dissolved steadily. No gas was evolved. The magnesium lost 0·0015 gram, and the silver lost 0·1167 gram, the ratio of the loss per unit area being Ag : Mg : : 61·5 : 1.

Electrical Phenomena.—The difference of potential between two metals in concentrated acids cannot be measured with the quadrant electrometer in the ordinary way, because in certain cases the chemical changes are different according as the circuit is closed or open. The influence of each metal on the rate of solution of the other is in most cases strongly marked. With the copper-silver couple the resistance increases rapidly on short circuit, apparently at the surface of the copper. The quantity of current is not proportional to the weight of silver dissolved. This part of the subject will be dealt with in a future paper.

Sodium and Sulphuric acid (rel. dens. 1·84).—A freshly-cut cube of sodium, about 5 mm. each way, impaled on the end of a strip of the metal used, was dropped into a test-tube containing about 15 c.c. of the acid, the tube being immersed in a jar of water (16°), the mouth of which was inclined away from the operator. As a further precaution a glass screen was used. The initial action was in most cases over in less than five minutes. The results of the experiments may be summed up as follows.

Sodium alone, weighted with a glass rod to sink it, was less rapidly attacked by strong sulphuric acid at 16° C. than by water. The action was moderate but steady. Bubbles of gas were freely given off, and very little heat was evolved. The sodium was completely dissolved in about 20 minutes, a small quantity of a whitish substance being formed near it towards the end of the process.

The contact of another metal with sodium exerts an influence on the rate and manner of its solution in strong sulphuric acid. In most cases the action of the solvent is much retarded. The gas evolved comes from the *entire surface* of the platinum, carbon, or iron, when these substances are employed, and is given off freely from first to last. No bubbles appear on the sodium which is clean and bright. The iron-sodium couple lasted 40 minutes, the platinum-sodium about two hours, and the carbon-sodium was still acting slowly after eight hours. In this case gas came from the sodium, and none from the carbon for the first 10 minutes after the initial effervescence was over. Then the sodium became quiescent, and bubbles rose from the carbon. Sulphur was separated after a while.

With lead and tin the action was similar, but much slower. The sodium was not so clean and the liquor became very turbid.

The tin acquired a brownish-yellow coating and the lead assumed a grey colour. It was several days before the sodium disappeared.

Zinc exerts comparatively little restraining action, but makes a very turbid solution.

An aluminium-sodium couple, weighted with a glass rod to sink it, evolved torrents of gas, and after about five seconds the sodium caught fire.

A magnesium-sodium couple similarly weighted gave a flash of light as it touched the liquid. Then, for about three seconds, there was a copious evolution of gas, and the sodium burst into flame while completely submerged.

With the cadmium-sodium couple the action was extremely slow. Fewer bubbles came from the sodium than from the cadmium, which became covered with a brown film. The liquor was turbid.

Coming now to those metals which produce a markedly different effect.

Nickel scarcely evolves any gas, but is soon coated *near the sodium* with a brownish film, while a few bubbles rise from the sodium. Antimony exerts the most powerful restraining influence of any substance yet tried. The initial action is very small. Bismuth behaves in much the same way. Both these metals become coated with a film near the sodium. Very little gas is evolved, and what there is comes from the sodium, which remains for days undissolved.

Silver in contact with sodium turns dark. Very few bubbles appear on either metal, but the sodium, which is quite clean, is visibly smaller after two hours.

Thus a magnesium-silver couple is almost inert in the acid, and a sodium-silver couple acts very slowly, but a magnesium-sodium couple bursts into flame, whereas either metal separately would be a long time in dissolving.

Copper evolves no gas, but becomes coated with the gas given off from the sodium, and presents a reddish fawn-coloured film. After an hour or so a secondary action sets in, apparently from the decomposition of some substance formed near the sodium; and those parts of the copper which remained bright are attacked, the production of an insoluble dark-brown compound, rendering the liquid turbid. The sodium is brilliantly clean, and during the first stage of the reaction evolves gas slowly. This gas has no perceptible smell, but turns paper moistened with iodate of potassium and starch solution faintly blue after a while. The acid liquid does not bleach litmus or indigo, and gives no precipitate, and only a slight brown colouration on boiling, with nitrate of silver. Iodine is only slightly decolourised by it, and it is not affected by permanganate to a greater extent than the fresh acid. The turbid liquid gives off sulphur dioxide on heating.

*134. "The action of light on oxalic acid." By A. Richardson.

Downes and Blunt, in 1879, observed that solutions of oxalic acid evolve carbon dioxide when exposed to light. In the present paper the author shows that hydrogen peroxide is also formed. Experiments are described in which this was found to be the case with numerous specimens of oxalic acid obtained from different sources, and carefully purified. The presence of the peroxide was proved by the titanic acid and chromic acid tests.

The decomposition of the acid was further studied in order to determine whether complete oxidation of the carbon to carbon dioxide occurred, or whether products of partial oxidation were also formed. The results of experiments in which the carbon dioxide evolved during the decomposition of a known weight of acid was estimated, showed that the oxidation of the carbon was complete.

The absence of intermediate products of oxidation seem to indicate that the formation of the peroxide is the direct result of the oxidation of the hydrogen of the acid, and is not brought about by secondary changes.

Experiments were also made in order to observe the influence of the concentration of the acid on the formation of the peroxide. The results obtained showed that while the total amount of hydrogen peroxide formed in the solution increased with the concentration of the acid, the proportion of peroxide formed to acid decomposed simultaneously decreased. The author draws the following conclusions:—

(1) Hydrogen peroxide is stable in solutions of oxalic acid in the dark.

(2) It is fairly stable in these solutions when exposed to light if excess of oxygen is present.

(3) Rapid decomposition of hydrogen peroxide occurs in solution of oxalic acid in absence of oxygen when their solutions are exposed to light.

*135. "English jute fibre." By A. Pears, jun.

In continuation of previous observations (*Trans.*, 1893), the seed saved from the plants grown in 1892 was sown at two periods, March and June, 1893. Parallel with these, cultivations were made from Indian seed. The plants were cut down in the late autumn when the seed is mature, and the four specimens of fibre obtained were compared.

Slight differences were observed in the resistance to hydrolysis and in the percentages of cellulose, the specimens from the early sowings being the better.

One specimen from the English seed (1892) contained 43 per cent. of carbon and 6 per cent. of hydrogen. It furnished 8·5 per cent. of furfural (calculated on the fibre), and absorbed 15 per cent. of chlorine.

The two last numbers are similar to those obtained with the normal fibre—whereas the composition shows an important divergence in the percentage of carbon, the normal percentage being 46·5

It is evident, therefore, from the study of these artificial cultivations, that they exhibit the essential features of jute-fibre, and differ chiefly in the degree of hydration, which is dependent on the conditions of growth. The specimen may in fact be regarded as a hydrated modification of the normal fibre, with which it corresponds in all the characteristic properties, differing merely in external features (colour, softness, &c.).

*136. "Natural oxycelluloses. I. Celluloses of the Gramineæ." By C. Smith.

The experiments, of which this communication is a preliminary account, are undertaken in extension of the results recently obtained by Messrs. Cross, Bevan and Beadle (*Ber.*, 1893).

The "celluloses" of esparto and the cereal straws, as isolated by the well-known processes of the paper maker, were further purified, and (1) their ultimate composition, (2) the amount of furfural obtained on boiling with aqueous hydrochloric acid (1·06 rel. dens.) with following results.

	(1).		(2).
	C.	H.	Furfural per cent.
Straw "Cellulose"	42·4	5·8	12·5
Esparto "Cellulose"...	41·4	5·6	12·2

These "celluloses," therefore, are oxycelluloses, and, since they do not give the reactions characteristic of the pentoses, they are of the type of those obtained by Cross and Bevan by regulated oxidation of the normal celluloses (*loc. cit.*).

Such oxycelluloses being widely distributed in nature, it becomes important to study their physiology. A course of systematic observations has therefore been undertaken on the germination and growth of the barley plant in relation to the composition and constitution of its permanent tissue ("cellulose").

It has already been observed that, by germination in the dark and growth of the sprouts (etiolated) until the endosperm is nearly exhausted, there is a considerable increase in the furfural-yielding constituents (60—80 per cent.), the early material of the tissue giving 5 per cent. furfural, and at the same time no pentose reaction, which proves it to be an oxycellulose. The results are still more marked in the case of the tissues of plants grown in the light.

Discussion.

Mr. Warington hoped that the authors would continue this investigation, as the subject was of much importance in relation to the digestibility of animal food. They had already established the important fact that the production of furfural can no longer be utilised for the estimation of the pentoses, since the oxycelluloses also furnish this compound.

*137. "Preliminary note on the volatilisation of salts during evaporation." By G. H. Bailey, D.Sc., Ph.D.

From experiments, carried out for the most part with the chlorides of the alkali metals, it was found that an appreciable amount of the salt was lost during evaporation of the aqueous solutions, although every precaution was used to prevent this occurring mechanically.

The amount of loss was found to be greater with the haloid compound of elements of higher atomic weight, and also greater the more concentrated the solution.

With lithium chloride of about one-fifth normal strength, it amounted to 0·35 milligrams per litre of water evaporated, and with calcium chloride of the same strength, 2·4 milligrams, whilst with lithium chloride containing about 38 grams to the litre the loss was 2·45 milligrams, and with cæsium chloride containing 286 grams to the litre it was 18·86 milligrams.

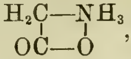
From the results obtained, it seems likely that when accurate determinations have been made on a more extended scale they may be the means of throwing light on the nature of solution and upon the vapour tension and vapour density of salts at comparatively low temperatures.

The observations also reveal a source of error which, in the case of some estimations, will involve the making of a large correction, and which must, at all events, receive consideration in all investigations where a high degree of accuracy is of essential importance.

138. "Constitution of glycocine and its derivatives." By Joji Sakurai, Professor of Chemistry, Imperial University, Japan.

Glycocine is usually represented as amido-acetic acid,

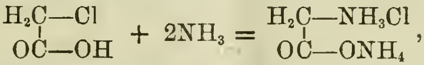
$$NH_2{\cdot}CH_2{\cdot}CO_2H,$$

but, as was first suggested by Erlenmeyer and Sigel (*Ann.*, **176**, 349), it ought to be regarded as an internal ammonium salt of the constitution  $\begin{array}{l} H_2C—NH_3 \\ \;\;| \qquad | \\ OC—O \end{array}$, the analogy of glycocine with betaïne, and its behaviour towards mustard oils (Marckwald and others, *Ber.*, **24**, 3279) supporting the latter view of its constitution. Other properties of glycocine are also in best accordance with the latter formula, and there is not a single reaction which needs to be expressed by the ordinarily employed open formula.

That, in spite of the evident claim of the internal ammonium theory to be exclusively adopted, the open formula is almost universally employed is due, partly, at any rate, to the erroneous manner in which the formation of glycocine has been hitherto represented. The change which occurs when ammonia acts upon chloracetic acid is not to be represented merely by the diagram

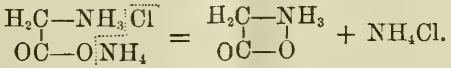
$$NH_2\boxed{H + Cl}CH_2{\cdot}CO_2H,$$

We must admit that, in this case, ammonia not only goes to neutralise chloracetic acid, but also to form an ammonium chloride, the latter part of this change being analogous to that which occurs when ammonia acts on alkyl halides:—



$$\begin{array}{l} H_2C—Cl \\ \;\;| \\ OC—OH \end{array} + 2NH_3 = \begin{array}{l} H_2C—NH_3Cl \\ \;\;| \\ OC—ONH_4 \end{array},$$

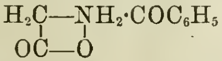
the ammonium compound thus formed then decomposing, by the action of heat, into glycocine and ammonium chloride:—



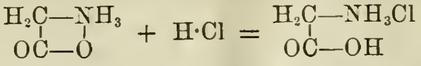
$$\begin{array}{l} H_2C—NH_3\boxed{Cl} \\ \;\;| \\ OC—O\boxed{NH_4} \end{array} = \begin{array}{l} H_2C—NH_3 \\ \;\;| \qquad | \\ OC—O \end{array} + NH_4Cl.$$

This conception of the mode of formation of glycocine is not a matter of speculation, but is only an expression of actual facts, and it leads *necessarily* to the internal ammonium theory of its constitution. The consideration of other modes of formation of glycocine leads to the same conclusion.

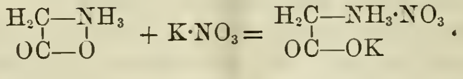
Again, the modes of formation of sarkosine and betaïn can only be satisfactorily expressed in a manner similar to that above described in the case of glycocine.

Hippuric acid, like glycocine itself, must also be represented as a closed chain,  $\begin{array}{l} H_2C—NH_2{\cdot}COC_6H_5 \\ \;\;| \qquad | \\ OC—O \end{array}$; its acid character, feeble as it is, is easily understood from the circumstance that the nitrogen is combined with an acid group, namely, COC_6H_5. That hippuric acid and other amido-acids do not contain the group CO_2H, is supported by the fact that all attempts hitherto made to obtain acid chlorides from them have been attended with failure.

The formation of *addition compounds* of glycocine presents no difficulties to the acceptance of the closed formula; in fact, the ring opens by addition, the nitrogen atom being not yet known to be capable of combining with more than five monovalent radicals. Thus,



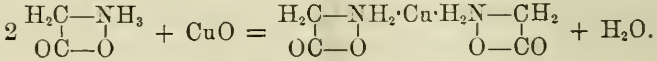
$$\begin{array}{l}H_2C-NH_3\\ \;\;|\qquad\;\;|\\ OC-O\end{array} + H{\cdot}Cl = \begin{array}{l}H_2C-NH_3Cl\\ \;\;|\\ OC-OH\end{array}$$



$$\begin{array}{l}H_2C-NH_3\\ \;\;|\qquad\;\;|\\ OC-O\end{array} + K{\cdot}NO_3 = \begin{array}{l}H_2C-NH_3{\cdot}NO_3\\ \;\;|\\ OC-OK\end{array}.$$

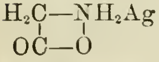
It is to be observed that in order to explain the formation of the potassium salt by the ordinary formula of glycocine we must suppose that a double decomposition first occurs with formation of potassium amido-acetate and nitric acid, and that the latter then unites to the amidogen group.

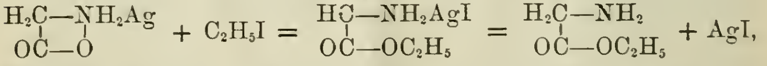
Passing now to the *metallic derivatives* of glycocine, their formation likewise finds a most satisfactory explanation in the closed formula. Thus, the deep blue colour of the copper compound and its solubility in alkalis distinguish it from ordinary carboxylic salts of copper, and lead us to the conclusion that it is most probably a cuprammonium compound, a conception which can be easily expressed in the following manner:—



$$2\begin{array}{l}H_2C-NH_3\\ \;\;|\qquad\;\;|\\ OC-O\end{array} + CuO = \begin{array}{l}H_2C-NH_2{\cdot}Cu{\cdot}H_2N-CH_2\\ \;\;|\qquad\;\;|\qquad\qquad\qquad\;\;|\qquad\;\;|\\ OC-O\qquad\qquad\qquad\;\; O-CO\end{array} + H_2O.$$

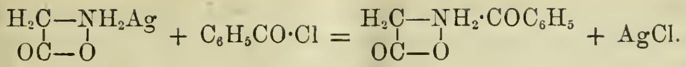
If, however, we regarded the copper compound as an amidated derivative, and gave it the constitution $Cu(NH{\cdot}CH_2{\cdot}CO_2H)_2$, we should have to make the baseless assumption that the hydrogen of the carboxyl group remains unreplaced by copper, even when digested with an excess of cupric oxide. If, on the other hand, we regarded it as $(NH_2{\cdot}CH_2{\cdot}CO_2)_2Cu$, taking glycocine as a carboxylic compound (an acid), because it dissolves oxide of copper and some other metallic oxides, we might argue that ammonium chloride or even ammonia itself, is also an acid!

Silver glycocine must likewise be regarded as having the constitution  $\begin{array}{l}H_2C-NH_2Ag\\ \;\;|\qquad\;\;|\\ OC-O\end{array}$; this formula can alone account for the formation of amido-acetic ether, on the one hand, by the action of ethyl iodide—



$$\begin{array}{l}H_2C-NH_2Ag\\ \;\;|\qquad\;\;|\\ OC-O\end{array} + C_2H_5I = \begin{array}{l}H_2C-NH_2AgI\\ \;\;|\\ OC-OC_2H_5\end{array} = \begin{array}{l}H_2C-NH_2\\ \;\;|\\ OC-OC_2H_5\end{array} + AgI,$$

and the formation of hippuric acid, on the other, by the action of benzoyl chloride—



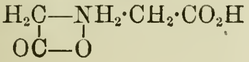
$$\begin{array}{ccc}H_2C & — & NH_2Ag\\ | & & |\\ OC & — & O\end{array} + C_6H_5CO\cdot Cl = \begin{array}{ccc}H_2C & — & NH_2\cdot COC_6H_5\\ | & & |\\ OC & — & O\end{array} + AgCl.$$

It must be observed that in the latter change an opening of the ring, as in the case of the action of ethyl iodide on silver glycocine, could not occur, because both the radicles Cl and COC_6H_5 are negative.

If, on the other hand, silver glycocine were regarded either as $NHAg\cdot CH_2\cdot CO_2H$ or $NH_2\cdot CH_2\cdot CO_2Ag$, we could not satisfactorily explain the formation of amido-acetic ether and of hippuric acid respectively.

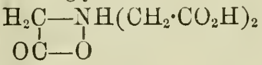
The examination of the properties of di- and tri-glycolamidic acids which are always represented as $NH(CH_2\cdot CO_2H)_2$ and $N(CH_2\cdot CO_2H)_3$ respectively, goes to further support the correctness of the closed formula for glycocine. These compounds behave only as mono- and di-basic acids towards alkalis and alkaline earths; it is only those of their salts, which contain silver, copper, and a few other metals, more or less characterised by the ease with which they form ammoniated derivatives, that may be regarded as di- and tri-basic. These facts are inexplicable by their accepted constitution, but receive an ample explanation from the following formulæ:—

Diglycolamidic acid.



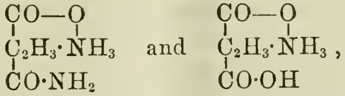
$$\begin{array}{ccc}H_2C & — & NH_2\cdot CH_2\cdot CO_2H\\ | & & |\\ OC & — & O\end{array}$$

Triglycolamidic acid.



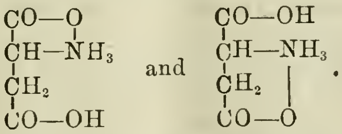
$$\begin{array}{ccc}H_2C & — & NH(CH_2\cdot CO_2H)_2\\ | & & |\\ OC & — & O\end{array}$$

All the so-called amido-acids must be regarded as constituted like glycocine. Thus asparagine and aspartic acid should be respectively represented by the formulæ—



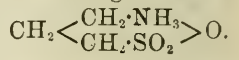
$$\begin{array}{ccc}CO & — & O\\ | & & |\\ C_2H_3 & \cdot & NH_3\\ | & & \\ CO\cdot NH_2 & & \end{array} \text{ and } \begin{array}{ccc}CO & — & O\\ | & & |\\ C_2H_3 & \cdot & NH_3\\ | & & \\ CO\cdot OH & & \end{array},$$

a view which is supported by the properties of these compounds. According to this conception, there should exist not only two chemically isomeric asparagins, as is predicted by the current theory, but also two aspartic acids, represented by—



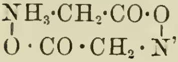
$$\begin{array}{ccc}CO & — & O\\ | & & |\\ CH & — & NH_3\\ | & & \\ CH_2 & & \\ | & & \\ CO & — & OH\end{array} \text{ and } \begin{array}{ccc}CO & — & OH\\ | & & \\ CH & — & NH_3\\ | & & |\\ CH_2 & & |\\ | & & |\\ CO & — & O\end{array}.$$

At present only one aspartic acid is known, but there are reasons to believe that another will be discovered.

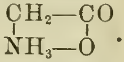
Finally, the term "amido-acids" should be dropped from chemical nomenclature, in accordance with the internal ammonium theory of the constitution of these compounds, and replaced by the words *glycocines* and *taurines*, to be applied respectively to the so-called amido-carboxylic acids and amido-sulphonic acids. Thus, alanine, asparagine, and aspartic acid should be called *propionic*, *succinamic*, and *succinic glycols* respectively, whilst γ-amido-propyl sulphonic acid (Gabriel and Lauer, *Ber.*, **22**. 2988) should be changed to *trimethylene-taurine* and represented by the formula  $CH_2{<}\begin{array}{l}CH_2{\cdot}NH_3\\CH_2{\cdot}SO_2\end{array}{>}O$.

139. "Note on the constitution of glycocine." By James Walker, D.Sc.

In connection with the question as to the constitution of glycocine, which is raised by Professor Sakurai in the foregoing paper, Professor Dunstan suggested that I should bring together any physical facts which might bear on the subject.

Physical methods throw at present little light on the constitution of glycocine. The only question which they decide with certainty is that the molecule of glycocine is not a double molecule of the formula  $\begin{array}{l}NH_3{\cdot}CH_2{\cdot}CO{\cdot}O\\ \mid \qquad\qquad\quad \mid\\ O{\cdot}CO{\cdot}CH_2{\cdot}N\end{array}$, as some have supposed, since the depression of the freezing point in its aqueous solutions shows that the molecular weight corresponds with the simple, and not with the double, formula. To the objection which might be raised, that this low molecular weight could be due to an electrolytic dissociation of the double molecule, there is the sufficient answer that an aqueous solution of glycocine is an extremely feeble conductor of electricity. I have found that a decinormal solution of the substance does not conduct very many times better than ordinary distilled London water. Whether the slight conductivity is due to the presence of impurities, or to actual electrolytic dissociation of the glycocine, must remain for the present undecided. Even if glycocine were proved to be ionised in aqueous solution, it is not certain what the ions would be, for we do not know whether under these conditions glycocine acts as an acid or a base. I have shown (*Zeit. physikal. Chem.*, **4**, 331) that glycocine in an equivalent solution of hydrochloric acid acts as a base of nearly the same strength as thiazole; but undoubtedly in an equivalent solution of an alkali it would act in a corresponding manner as an acid. A comparison of the amount of hydrolysis in the two sets of salts may serve to settle whether glycocine in aqueous solution is acid, basic, or strictly neutral, and it is my intention to perform the necessary experiments.

In as far as glycocine behaves as a base, it must, according to Arrhenius' theory, supply hydroxyl ions, which can only come from the

compound $NH_3OH\cdot CH_2\cdot COOH$, a hydrated form of glycocine, which in its turn might either be derived from $NH_2\cdot CH_2\cdot COOH$, or  $\begin{array}{l}CH_2—CO\\ \,| \qquad\quad |\\ NH_3—O\end{array}$.
It is possible that the hydrated form may exist to a great extent in solution, while the solid form is anhydrous, for this is undoubtedly the case with betaïne.

While physical methods, then, are mostly silent with regard to the constitution of glycocine itself, they yield decisive evidence that many glycocine derivatives must be represented by an open, and not by a closed, chain. Acetic acid has a dissociation constant $K = 0{\cdot}0018$, very many times greater than any that could be attributed to glycocine, which ranks in point of conductivity with the phenols. Phenyl glycocine, $NHPh\cdot CH_2\cdot COOH$, on the other hand, has a constant $K = 0{\cdot}0041$, so that the introduction of a phenyl group in the place of one of the hydrogen atoms of the amidogen, has raised the conductivity far above that of acetic acid. Consequently, if acetic acid contains a carboxyl group, phenylglycocine must, *à fortiori*, contain one. The same is evident in still greater degree in the case of hippuric acid, $K = 0{\cdot}0222$, and aceturic acid, $K = 0{\cdot}0230$. The amidobenzoic acids have dissociation constants less than that of acetic acid, but still incomparably greater than that of glycocine, so that they must be regarded as possessing a carboxyl group.

If we are to trust to analogy, therefore, the evidence afforded by the electrical conductivity goes to show that glycocine has not the ring constitution, but the ordinarily accepted constitution represented by the formula $NH_2\cdot CH_2.COOH$.

140. "On the oxidation of the alkali metals." By Wilmot Holt and W. Edgar Sims, B.Sc.

The authors have examined the oxides of the alkali metals with a view to ascertain how far stability and composition of the oxides is dependent on the atomic weight of the element from which it is derived, the observations already recorded being so conflicting, and, in many cases, so incomplete, that it was found quite impossible to make any generalisations from them. The general results of their examination are as follows:—

1. Potassium and sodium (and probably lithium) are not attacked by perfectly dry oxygen, and may be distilled in it, without undergoing oxidation.

2. Lithium, when oxidised in oxygen gives rise to the monoxide Li_2O, sodium (a member of the same group, though in the odd series) under certain conditions forms the monoxide Na_2O, whilst in the case of potassium it has been impossible to obtain the monoxide K_2O.

3. The ultimate products of oxidation are: with lithium the monoxide and slight traces of a peroxide; with sodium, the dioxide Na_2O_2; and with potassium, the tetroxide K_2O_4, which must be regarded as the most definite and stable oxides of these metals.

4. The monoxide of potassium K_2O. is not formed by the oxidation of potassium in any of the oxides of nitrogen as stated by previous observers, and there is no evidence either of the existence of this or of any lower oxide in the pure condition.

5. The only other oxides of which the authors have been able to find any evidence, in addition to those mentioned under Section 3, are Na_2O, K_2O_2 and K_2O_3, these only being obtained under certain conditions owing to their instability.

6. Both potassium and sodium, when oxidised in nitric oxide or the red oxides of nitrogen, form varying mixtures of nitrite and nitrate according to the conditions of the experiment.

Later experiments will probably show that the metals rubidium and cæsium, both of which have higher atomic weight than potassium, will combine with oxygen in still larger proportions.

141. "The action of iodine and of methyl iodide on aconitine." By Wyndham R. Dunstan, F.R.S., and H. A. D. Jowett, B.Sc.

In 1885 Jürgens described a crystalline, dark red *hydriodide of iodaconitine* ($C_{33}H_{46}INO_{12}.HI$), which he had obtained by mixing ethereal solutions of iodine and aconitine, and crystallising the product from chloroform and ether. The percentage of iodine found in the salt agreed closely with the formula given above. By acting on the salt with dilute ammonia he obtained a brown, amorphous substance, which he supposed to be iodaconitine. The authors find that when iodine acts on aconitine, dissolved in various liquids, the product is a variable mixture of *aconitine hydriodide*, *aconitine periodide*, and an amorphous, neutral substance, which appears to be *iodo-aconitine*, but since it cannot be crystallised it is difficult to characterise. The principal changes may be represented by the equations (1) $2C_{33}H_{45}NO_{12} + I_2 = C_{33}H_{45}NO_{12},HI + C_{33}H_{44}INO_{12}$, (2) $C_{33}H_{45}NO_{12}HI + xI_2 = C_{33}H_{45}NO_{12}HI,xI_2$.

The crystals obtained by Jürgens consist of an unstable aconitin periodide, which cannot be crystallised without losing iodine. The dark brown crystals originally obtained gradually become lighter on recrystallisation, and finally are resolved into the colourless aconitine hydriodide. Analysis shows a gradually diminishing percentage of iodine as the recrystallisation is repeated until pure aconitine hydriodide is obtained. This salt was identified by its melting point (226°), and also by its furnishing pure aconitine (m. p. 188—189°), when decomposed with dilute ammonia.

The same unstable periodide may be obtained by adding iodine to an aqueous solution of aconitine hydriodide. The brown precipitate is crystallised from its solution in alcohol.

In attempting to isolate iodaconitine the mixture prepared by adding an ethereal solution of iodine to an ethereal solution of aconitine was dissolved in chloroform, and the solution was shaken with dilute ammonia. By this means a substance was obtained from this solution which contained much aconitine, and also a smaller amount of an amorphous compound, which was separated from aconitine by precipitating a solution in chloroform with ether. All attempts to crystallise this substance have failed. It is a greyish powder, which melts indefinitely near 208°, and is nearly insoluble in cold water, but readily dissolves in alcohol and chloroform. On analysis it furnished the percentage of iodine required by the formulæ $C_{33}H_{44}INO_{12}$. It does not possess basic properties.

In a previous communication (Trans., **51**, 403) it has been shown that when aconitine is heated in a closed tube with methyl iodide it dissolves, and that on cooling the solution crystals separate which contain the percentage of iodine required by aconitine methiodide. This substance has now been further investigated, and it has been found that the action of methyl iodide on aconitine is exceptional.

After recrystallisation from a mixture of ether and chloroform, the crystals melted at 226°, and agreed in all other respects with *aconitine hydriodide.* The action of methyl iodide on aconitine would seem to be represented by the equation $2C_{33}H_{45}NO_{12} + CH_3I = C_{33}H_{45}NO_{12}HI + C_{33}H_{44}(CH_3)NO_{12}$, but although distinct evidence of this simultaneous production of a methyl aconitine was obtained, all the methods employed to isolate it in a pure state have been unsuccessful. An impure base was obtained which furnished a hydrobromide melting near 218°, but during the precipitation of this salt and the regeneration of the alkaloid from it, decomposition apparently occurred, since aconitine was finally obtained. It would thus appear that if methyl aconitine is formed in this reaction, it is so unstable that it cannot be isolated. Other methods have been tried for its production, but these also have failed to furnish the compound.

RESEARCH FUND.

A meeting of the Research Fund Committee will be held in June. Fellows who desire grants are requested to send their applications to the Secretaries at Burlington House, not later than Tuesday, June 5th.

At the next meeting of the Society, on Thursday, May 3rd, there will be a ballot for the election of Fellows, and the following papers will be read :—

"The structure and chemistry of the cyanogen flame." By Professor Smithells.

"The condition in which carbon exists in steel." By J. O. Arnold.

"α-Hydrindone and its derivatives." By Dr. Kipping.

"Volatile compounds of lead sulphide." By J. B. Hannay.

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Issued 16/5/1894

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

No. 138. Session 1893–94.

May 3rd, 1894. Dr. Armstrong, F.R.S., President, in the Chair.

Messrs. R. L. Jenks and John McKillop were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Arthur Hadley, 226, Monument Road, Edgbaston, Birmingham; G. L. Parker, The Paddocks, Eccleston, Chester; John F. Rolfe, Homewood, Leytonstone, Essex; Herbert John Taylor, Fern Villa, 33, Russell Street, Eccles, near Manchester; Charles H. H. Walker, Prospect Place, Cainscross Road, Stroud.

The following were elected Fellows of the Society:—F. E. Alhusen, Joseph Beynon Ashcroft, Samuel Bernard Asher-Aron, Charles Henry Ashdown, Harry Bowes, Robert William Buttemer, Thomas Chambers, George Hugh Gabb, Arthur Robert Golden, Oswald Ernest William Hewitt, Charles T. W. Hirsch, Edwin James Jackman, Alex. Mitchell Kellas, William Albert Knight, John Abraham Kelly, James Mansell, Charles McMullan, Matthew A. Parker, Thomas John Roberts, Fredk. Wallis Stoddart, James Swinburne, Edwin Terry, Henry L. Wheeler.

Of the following papers those marked * were read:—

*11. "The structure and chemistry of the cyanogen flame." By Arthur Smithells, B.Sc., and Frankland Dent, B.Sc.

The flame of cyanogen burning in air consists of two distinct regions—an inner cone of a bright peach-blossom tint and an investing mantle whose colour shades off from a deep blue to greenish-grey.

The authors have endeavoured to ascertain the chemical changes that occur in different parts of the flame by the means employed by Smithells and Ingle for the flames of hydrocarbons (Trans., 1892, 204).

When cyanogen is burnt in the cone-separating apparatus and sufficient air is added, a separation takes place corresponding in colour to the two-coned structure of the original flame. A slight increase in the supply of air causes the inner cone to become bluer and the outer cone greener, whilst a further increase extinguishes the outer cone.

The authors have made a series of analyses of the interconal gases produced in the flame under varying conditions. These analyses show—(i.) The separation of the cones of a cyanogen flame is possible in the apparatus used when the ratio of air to cyanogen is 3·3 : 1 (*i.e.*, about one-third of the amount necessary for complete combustion), and the cones remain intact until the air supply is increased to twice this amount. After this the interconal gases become so diluted with carbon dioxide and nitrogen that they can no longer burn in a second cone. (ii.) When cyanogen is burning in the apparatus with the addition of the minimum quantity of air necessary for the separation of the cones, carbon monoxide is practically the only oxidation product. (iii.) A small quantity of carbon dioxide is formed in the interconal gases. As the air supply is increased the quantity of carbon dioxide increases until it amounts to about half the volume of the accompanying carbon monoxide. (iv.) The interconal gases contain unburnt cyanogen amounting in the case of the minimum air supply to $7\frac{1}{2}$ per cent., and diminishing in quantity to *nil* as the air supply is increased. (v.) Small and variable quantities of oxides of nitrogen are obtained in the interconal gases. (vi.) A variation in the dimensions of the apparatus makes no important difference in the results.

The authors consider that their results are in accordance with Dixon's as to the rate of explosion of cyanogen, which showed that the highest rate corresponds with oxidation of the carbon to carbon monoxide. They conclude that the inner cone of the ordinary cyanogen flame is determined by the formation of carbon monoxide, and the outer one by the combustion of the carbon monoxide.

The outer cone of a cyanogen flame is not suppressed even when the cyanogen and air have been carefully dried, and this might seem to conflict with the view that it is due to the combustion of carbon monoxide. The authors, however, have shown that the outer cone can be extinguished by drying the gases, provided that it is not too near the inner cone. As it is brought nearer to the inner cone, a point is reached where the temperature of the carbon monoxide is sufficient to ensure its combustion in spite of the dryness of the gases. These results are in harmony with Dixon's observations.

The authors have not found any evidence of the direct combustion of the nitrogen of cyanogen within the flame; their observations go rather to show that oxides of nitrogen are formed on the exterior where they produce a characteristic, greenish tinge.

*12. "The results of measurements of the freezing points of dilute solutions." By Harry C. Jones.

This is a reply to Pickering's recent criticisms (Trans., **51**, 293) of the author's work. When the results of Pickering, Loomis, Raoult and the author on the freezing points of dilute cane sugar solutions are compared, differences are seen to exist which at present are inexplicable. It may be possible that the different workers have measured slightly different points of equilibrium. Notwithstanding such differences, Pickering states that when Raoult's, Loomis's and his own results are plotted as curves they "form figures almost identical."

Pickering's method of manipulating results in his curves, which consisted in subtracting a constant multiple of the strength from the depressions, and plotting the number thus obtained ($D - xm$) against the strengths (m), instead of plotting the depressions directly, involves the following errors.

I. It changes the relations between the freezing point lowerings found experimentally, without changing the relations between the concentrations.

II. It magnifies all errors; and

III. It magnifies them differently in different parts of the curves.

The true curves for sulphuric and phosphoric acids were drawn and compared with Pickering's curves from the same results, illustrating the manner in which Pickering obtains the "breaks." The curves which Pickering drew from the author's results by his method involving the above-mentioned errors were shown, by comparison with the true curves, to bear no direct relation to the results.

The tables which Pickering prepared from the results of others in order to throw doubt on the correctness of the author's results would equally justify exactly the opposite conclusion, if he had dealt with actual instead of manipulated differences.

DISCUSSION.

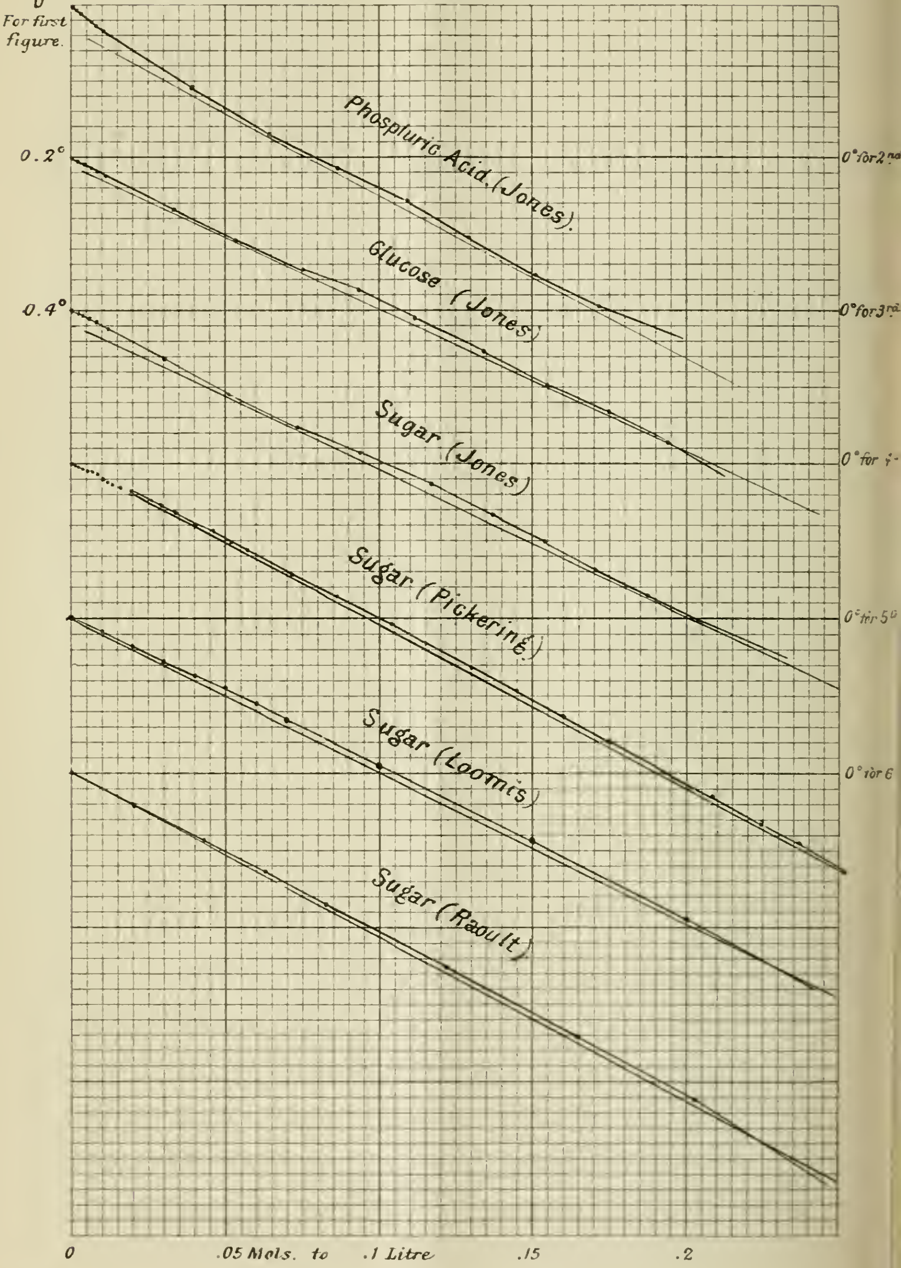
Mr. PICKERING said that all Mr. Jones's arguments were beside the point, for the comparison which he had made of Mr Jones's results with those of other observers were made by calculation from the *unaltered* experimental values without the use of any plottings whatever (Trans., p. 303, line 32, *et seq.*). Nor were Mr. Jones's arguments valid even against those diagrams, the peculiarities of which led him to make this comparison. His first argument was founded on a fundamental misconception of an elementary fact in geometry—the fact that an alteration in the ratios of the ordinates does not necessarily involve an alteration in the nature of a curve—and the other two were due to a thorough confusion between actual and percentage errors, and between the operations of subtraction and multiplication. The experimental error, being an inseparable portion of the experimentally observed depressions, the former cannot become multiplied unless the depressions themselves are multiplied also, but $D - xm$ represents an operation of subtraction from, and not multiplication of, the depressions (D). An error of a given magnitude is represented by a definite space uniformly throughout the $D - xm$ figures, just as much as it is in the direct plottings of D.

The proof that the subtraction of xm does not alter the nature of the curve is perfectly simple. If the depressions are proportional to the strength of the solutions (m), we shall have $D = xm$ in the direct plotting, and $D' = (a + x)m$ in the other, both of which represent straight lines: if the depressions are not proportional to the strength, then the plottings will form a curve; but the nature of a curve at any point, m_2, depends on whether the ordinate at that point is greater or less than the mean of two ordinates at points m_1 and m_3, equidistant on either side of it, *i.e.*, whether $BB' \gtrless \frac{1}{2}(AA' + CC')$; in the curve obtained by plotting the values $D - xm$, the nature of the curvature will depend on whether $BB' - xm_2 \gtrless \frac{1}{2}(AA' - xm_1 + CC' - xm_3)$, but since $m_2 = \frac{1}{2}(m_1 + m_3)$, this expression is identical with the former; any breaks, waviness, or other singularities which exist in the one figure must necessarily exist in the other.

Since the $D - xm$ figures show waviness, it is certain, therefore, that the direct plottings of D must show waviness also, and even on the very restricted scale of the accompanying diagram this waviness is clearly visible. Straight lines have been drawn against the figures to assist the eye in judging their form: with a similar assistance, the waviness of Mr. Jones's results may easily be seen in the drawings of them which he has given in the *Phil. Mag.*, Dec., 1893.

Their waviness can be proved equally well without the use of any diagram: it is only necessary to compare his values with those calculated for a properly-selected straight line, and it will be found that they cut this line at three points, and therefore must form a

OBSERVED DEPRESSIONS PLOTTED AGAINST STRENGTH.



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wavy figure. The line $x = 0{\cdot}195m$ is a convenient one to take for Mr. Jones's results with cane sugar, the waviness of which will then be found to depend on differences (errors) of as much as 0·015°.

The values shown by Mr. Jones for portions of the results obtained by different workers with cane sugar are sufficient to indicate the discrepancy between his results and theirs, for whereas an accumulated error of 0·0019° or 0·0016° would reduce to rectilinarity this part of the results of Pickering, Loomis, and Raoult, it would require errors of 0·006° to obliterate the curvature of Mr. Jones's results. But the exceptional character of the latter can be satisfactorily seen only by comparing the whole series at our disposal; this has been done roughly in the last four figures of the accompanying diagram.

Dr. JAMES WALKER said that he understood Mr. Jones to take objection not to Mr. Pickering's observation that his curves possessed a wavy character, but merely to the distortion of these curves which resulted from the method of treatment adopted by Mr. Pickering in his diagrams. If the depressions of freezing point had been strictly proportional to the concentrations instead of only roughly so, then, of course, no distortion would have resulted.

Mr. E. H. HAYES explained from the mathematical standpoint the precise relation between the figures obtained by the ordinary plotting preferred by Mr. Jones, and by the modified plotting which was necessarily adopted by Mr. Pickering in order to make the experimental error and the irregularities of the "lowering" easily visible on a diagram of moderate size.

Whichever plotting was used, a temperature error of given magnitude was represented by the same length, whatever the strength of the solution might be. Taking an ordinary plotting, and drawing a straight line through the origin, the ordinates $(D - xm)$ of the modified plotting were simply the difference between the ordinates (D) of the ordinary plotting and those of the straight line (xm) at the same strengths. (Mr. Pickering had, of course, obtained the values of $D - xm$ by calculation and not by measurement.) If the two plottings were drawn together on the same scale, and the plane of one of them turned round the temperature axis through any angle, the lines joining corresponding points on the two curves were all parallel, that is to say, either curve was the projection, or, in more popular language, the shadow of the other, a simple mathematical fact which absolutely annihilated the claim of Mr. Jones that the irregularities discovered by Mr. Pickering were introduced by his method of plotting, and that the curves obtained by the latter bore no direct relation to the experimental results. An ordinary plotting, if mathematically correct, would of necessity contain any such singularity as a waviness or a break if such appeared in the modified plotting, although the steep slope of the curve in the former, and its far greater length would prevent them from being as conspicuous. On an unmodified plotting on the same scale as Mr. Pickering's published diagrams, the temperature ordinate for a lowering of 0·32° would have a length of about 10 in. If the observed lowering were strictly proportional to the strength, the experimental points in the ordinary diagram would lie, on the average, evenly about a straight line, and, therefore, since the shadow of a straight line was a straight line, would lie evenly about a straight line in the modified diagram, from which it followed that the modified plottings exhibited by Mr. Jones proved conclusively either the existence of extremely serious errors, or that in the cases chosen for illustration, the lowering varied in a highly complex manner, the irregularities, though small as compared with the total depression, being large as compared with the estimated experimental error.

Mr. Jones had pointed out three details in which the modified plotting differed from the ordinary one.

(1.) That it changed the relation between the lowerings and the strengths.

(2.) That the experimental errors did not appear in their true relations to the lowerings.

(3.) That the experimental error was not multiplied to the same extent at different strengths.

Mr. Jones's numerical illustrations, however, had clearly shown that in both (1) and (2) the word lowering was made to bear two different meanings—the actual lowering (D), and the $(D - xm)$ of the modified plotting; and that in (3) the words "experimental error" did *not* mean the experimental temperature error (which would necessarily be represented on a constant scale for all strengths in the modified diagram) but a ratio which turned out to be simply $D - xm : D$, *i.e.*, the ratio of the ordinates of an ordinary and modified plotting drawn to the same scale. The numerical results obtained by Mr. Jones were simply a mathematical consequence of the fact that in the imaginary case he took, the actual lowerings were not exactly proportional to the strengths, and the only legitimate conclusion to be drawn from them (except the obvious one that the two forms of plotting were not identical) was that the modified plotting was perfectly adapted to the use to which it had been put by Mr. Pickering, viz., to render slight irregularities, which could otherwise be only adequately revealed by a troublesome mathematical investigation, at once obvious to the unaided eye.

•13. "The conditions in which carbon exists in steel." By J. O. Arnold and A. A. Read.

The authors have carried out experiments on the condition in which carbon exists in normal, annealed and hardened steels on a series of five steels containing 0·96, 0·57, 0·33, 0·16, and 0·06 per cent. of carbon respectively.

The method they have used in their determinations is a modification of the process of Binks and Weyl, originally proposed for the estimation of carbon in iron.

Two bars of polished steel of suitable size were suspended in separate beakers containing dilute hydrochloric acid (rel. dens. 1·02), placed in the same circuit, and connected with the positive pole of a single Bunsen cell, the cathodes being plates of platinum placed in a flat porous cell. At the end of the time allowed for solution the carbide was collected on a smooth filter paper and washed with water, alcohol, and finally with ether. The residue was washed off the filter paper into a weighed boat, and then dried in a vacuum. The carbon was estimated by direct combustion, the residue afterwards being used for the estimation of the iron.

From the results of a number of experiments the authors draw the following conclusions:—

1. The existence is confirmed of a carbide of iron possessing the formula Fe_3C, originally discovered by Abel and Müller by independent methods.

2. The normal carbide exists in two different forms identical in chemical composition.

(*a*.) A diffused carbide is scattered in granules or very small plates throughout the iron in normal steel. When isolated it is a greyish-black powder.

(*b*.) A crystalline carbide, arranged in comparatively large distinct plates in well-annealed steel; these plates are chiefly in the form of well-marked striæ, and consist of pure Fe_3C. They are identical with the microscopical laminæ of Sorby's "pearly" constituent, and they may be isolated as bright silver plates.

3. The percentage of the total carbon obtained as carbide is greater in hard than in soft steels.

In iron containing ..	0·1 per cent. ;	92 per cent.	Loss 8 per cent.
,, ,,	0·5 ,,	87 ,,	,, 13 ,,
,, ,,	0·25 ,,	74 ,,	,, 26 ,,

4. The above-mentioned loss does not appear to be due to decomposition, but rather to the presence of a readily decomposed subcarbide of iron (containing less carbon than the normal compound)

existing to the extent of about 25 per cent. in mild steel, and capable of existing to the same amount in cold, hard steel after the latter has been heated for some time at a white heat.

5. The loss being practically the same in well-annealed steel as in the normal steel, it cannot be due, as supposed by Ledebur, to the presence of "hardening carbon."

6. The carbon in hardened steel exists chiefly as an extremely attenuated carbide, or in solution, leaving on isolation a residue consisting mainly of "hydrate of carbon," mixed to a slight extent with carbide of iron. Whether the large loss of carbon (about 50 per cent. of the total) occurring during the galvanic decomposition of the hardened steel is due to the presence of a large percentage of sub-carbide or to evolved hydrocarbons, formed by the action of nascent hydrogen on the finely-divided free carbon, there is no conclusive evidence to show.

The authors have also experimented on a steel containing 1·73 per cent. of manganese and ·55 per cent. of carbon, and find that a portion of the iron is replaced by manganese, the double carbide apparently having the formula Fe_7MnC_3.

DISCUSSION.

Professor ROBERTS-AUSTEN observed that this was only a portion of a long series of experiments, many of which appeared to have been very carefully made. He regretted, however, to say that he entirely differed from the conclusions at which Mr. Arnold had arrived. He was not prepared to raise objections to the method employed, which, under the circumstances, was probably as good as any that could have been adopted; it was, moreover, a method which the speakers had himself used 30 years ago. He quite believed in the existence of Abel's carbide of iron, Fe_3C, but he considered that the authors of the paper had not offered any evidence which could be accepted in support of the presence in the steel of a new sub-carbide of iron. Without the exercise of the utmost care and absolute uniformity of conditions, nothing is easier than to lose carbon when steel is dissolved by electrolytic action.

Mr. BERTRAM BLOUNT said that he had had some experience in the use of the method described by the authors for isolating the carbon in steel, and had observed that the conditions of experiment had to be arranged in such a manner as to confine the reaction between certain limits. On the one hand an insufficiency of current permitted the escape of hydrogen (and therefore of hydrocarbons) due to the action of the acid on the iron *per se*, and on the other an excess of current might exert so strong an oxidising influence as not only to determine the complete suppression of the hydrogen and oxidation of ferrous to ferric chloride, but also to attack the carbon or carbides, the isolation of which was sought. It followed that the range for safe working lay between the point at which all the iron was converted into ferrous chloride without evolution of hydrogen as a lower limit, and that at which all the ferrous chloride was converted into ferric chloride, as an upper limit. In conclusion he would plead for a more general observance of the necessity of stating the precise working conditions, *e.g.*, voltage and current density, in describing electrolytic experiments, in order that any given experiment might be repeated at any time under conditions identical with those adopted by a previous observer.

14. "The 'cis-' and 'trans-' modification of tetramethylenedicarboxylic acid (1.2) and pentamethylenedicarboxylic acid (1.2)." By W. H. Perkin, jun., F.R.S.

The author has further investigated the tetramethylenedicarboxylic acid (1-2) which had been previously obtained (*Trans.*, **51**, 23) by heating the disodium derivative of ethylic butanetetracarboxylate, $(COOC_2H_5)_2{\cdot}CNa{\cdot}CH_2{\cdot}CH_2{\cdot}CNa(COOC_2H_5)_2$, with bromine, hydrolysis of the product, and elimination of two molecules of carbon dioxide at 200°.

The acid (m. p. 138°) thus obtained is the *cis*-modification, since when digested with acetyl chloride it yields an anhydride, $C_6H_6O_3$ (m. p. 75°), which dissolves in water, regenerating the same acid.

The *trans*-modification of tetramethylenedicarboxylic acid is obtained by heating the *cis*- acid with hydrochloric acid at 180°; it melts at 130°, and does not yield an anhydride when digested with acetyl chloride; on distillation, however, it is partially converted into the anhydride of the *cis*-acid.

Pentamethylenedicarboxylic acid (1-2) is obtained by an exactly similar series of reactions from ethylic pentanetetracarboxylate (*Trans.*, **51**, 244), but the acid (m. p. 160°) produced in this case is the *trans*-modification.

This, when heated with acetyl chloride at 140°, is decomposed, forming the anhydride of the *cis*-acid (m. p. 73°). *Cis* pentamethylenedicarboxylic acid is obtained from this anhydride by dissolving it in potash; it melts at 140°, and is much more readily soluble in water than the *trans*-acid into which it is quantitatively converted by heating with hydrochloric acid at 180°.

Baeyer, in his remarkable paper on the hexahydrophthalic acids (*Annalen*, **258**, 145), expresses the opinion that *trans* pentamethylenedicarboxylic acid, like *trans* hexahydrophthalic acid, should yield an anhydride of its own; but so far the author has not been successful in preparing this substance.

15. "Hexamethylenedibromide, $Br{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2Br$." By E. Haworth and W. H. Perkin, jun., F.R.S.

This substance may be obtained by the following series of reaction :—

Chloromethoxypropane, $Cl(CH_2)_3OCH_3$, is first prepared by heating chlorobromopropane, $Cl(CH_2)_3Br$, with sodium methoxide. It is a colourless oil, which boils at 119°, and when acted on in benzene solution with potassium, is converted into a high boiling oil which apparently contains dimethoxyhexane, thus—

$$2Cl{\cdot}(CH_2)_3OCH_3 + K_2 = CH_3O{\cdot}(CH_2)_6OCH_3 + 2KCl.$$

From this substance hexamethylene dibromide is obtained by the action of fuming aqueous hydrobromic acid at 150°. It is a colourless oil, which boils at 137—140° (20 mm.).

When a solution of this dibromide in *m*-xylene is acted on with sodium, a hydrocarbon, C_6H_{12}, is produced, which boils at 77—80°, and is apparently identical with hexamethylene, which Baeyer (*Annalen*, **278**, 111) obtained in the course of his researches on the reduction of benzene.

Hexamethylenedibromide reacts readily with the sodium derivative of ethylic malonate, sodium bromide being separated, and an oily product formed, which, when fractionated under reduced pressure, is separated into two fractions, boiling at 130—220° and 220—290°.

The lower fraction, on hydrolysis, yields an oily acid, from which, on distillation, a small quantity of substance was isolated, which boiled at 248—250°, and on analysis gave numbers agreeing with the formula $C_8H_{14}O_2$. This substance appears to be heptamethylenecarboxylic acid.

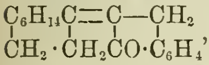
The higher fraction contains ethylic octanetetracarboxylate,

$$(COOC_2H_5)_2{\cdot}CH{\cdot}(CH_2)_6{\cdot}CH(COOC_2H_5)_2,$$

a colourless oil, which boils at 275—280° (60 mm.); on hydrolysis it is converted into a polybasic syrupy acid, which at 200° rapidly loses carbon dioxide forming sebacic acid, $COOH(CH_2)_8COOH$.

16. "α-Hydrindone and its derivatives." By F. Stanley Kipping, Ph.D.

The author gives an account of the preparation of α-hydrindone by the action of aluminium chloride on phenylpropionic chloride (Proc., **117**, 216), and points out that this method is very convenient for the preparation of large quantities of this ketone. When suitable conditions are chosen, the yield is very good, and, with the exception of one bye-product, namely, a substance which probably has the constitution $C_9H_7O\cdot CCl{:}CH\cdot CHPh$, no other compound is formed.

After referring to the behaviour of hydrindonoxime under various conditions, and bringing forward conclusive evidence that the oxime is converted into hydrocarbostyril by the action of phosphorus pentachloride (Proc., **129**, 240), several derivatives of hydrindone are described; amongst others, the products of condensation with benzaldehyde and with acetone, and a compound of the composition $C_{18}H_{14}O$, formed by condensation of two molecules of the ketone $2C_9H_8O - H_2O = C_{18}H_{14}O$. This substance is considered to be anhydrobishydrindone,  $\begin{array}{l} C_6H_{14}C{=}C{-}CH_2 \\ \vert \quad\;\; \vert \quad\; \vert \quad\;\; \vert \\ CH_2\cdot CH_2CO\cdot C_6H_4 \end{array}$, an analogue of the anhydrobisdiketohydrindene, prepared by W. Wislicenus and his co-workers. As, however, some of its properties do not completely harmonise with this view of its constitution, the investigation is being continued.

ADDITIONS TO THE LIBRARY.

I. *Donations.*

Companion to the British Pharmacopœia. By P. Squire. 16th Ed. Revised by P. W. Squire and A. H. Squire. London 1894. From the Editors.

Transactions of the Sanitary Institute. Vol. XIV, 1893. London 1894. From the Institute.

Smithsonian Institution. Annual Report of the Board of Regents to July 1891. Washington 1893. From the Institute.

Nature's Hygiene: a Systematic Manual of Natural Hygiene. By C. T. Kingzett. London 1894. From the Author.

The Blue Book of Amateur Photographers. British Societies, 1893. Edited by W. Sprange. London. From the Editor.

Pamphlets from the Authors.

Ribble Joint Committee. Report on the Nature and Treatment of Manufacturers' Waste Effluents. By W. Naylor. Preston 1893.

The Chemical Analysis of the Three Guns, at the U.S. Naval Academy, captured in Corea. By C. R. Sanger. (Proc. U.S. Naval Institute, XIX, No. 1.)

Nickel: The Occurrence, Geological Distribution and Genesis of its Ore Deposits. By P. Argall. (Colorado Sc. Soc. 1893.)

Nickel: Historical Sketch. By W. L. Austin. (Colorado Sc. Soc. 1893.)

The Mode of Occurrence of Gold in the Ores of the Cripple Creek District. By R. Pearce. (Colorado Sc. Soc. 1894.)

A Contribution to the History of Fire-Damp. By H. G. Graves. London and Newcastle-on-Tyne 1893.

Ancient Metals from Tell-el-hesy. By J. H. Gladstone. (Proc. Soc. Biblical Archæology 1894.)

De l'Emploi du Sulfate de Magnésie comme engrais. Par E. Siiz. Paris 1890.

II. *By Purchase.*

Handbuch der Stereochemie; unter Mitwirkung von P. Walden, herausgegeben von C. A. Bischoff. Band I. Frankfort a/M. 1893.

RESEARCH FUND.

A meeting of the Research Fund Committee will be held in June. Fellows who desire grants are requested to send in their applications to the Secretaries at Burlington House, not later than Tuesday, June 5th.

At the next meeting of the Society, on Thursday, May 17th, the following papers will be read:—

"The influence of moisture on chemical change." By H. Brereton Baker, M.A.

"Volatile compounds of lead sulphide." (Postponed from the last meeting). By J. B. Hannay.

"A specimen of early Scottish iron." By Margaret D. Dougal.

"The mineral waters of Cheltenham." By Professor Thorpe, F.R.S.

Erratum.—In the previous number of the "Proceedings," the numbering of the abstracts 131—141 should be altered to 1—10.

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Issued 31/5/1894.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

No. 139. Session 1893–94.

May 17th, 1894. Dr. Armstrong, President, in the Chair.

Professor D. Mendeléef, of St. Petersburg, Foreign Member of the Society, being present signed the Roll of Fellows.

Certificates were read for the first time in favour of Messrs. Cecil Cooke Duncan, Royal Agricultural College, Cirencester; Bhirkaji Edalji Ghasvala, Tardes, Bombay; Donald Gordon Forbes, Shillingstone, near Blandford, Dorset; Richard S. Ladell, 11, Lower Grosvenor Place, S.W.

Of the following papers those marked * were read:—

*17. "The influence of moisture on chemical action." By H. Brereton Baker, M.A.

Since the publication of a note in the Proceedings (May 4th, 1893) further investigations of the actions there mentioned have been made. Sulphur trioxide does not combine with highly purified lime; but a trace of moisture brings about vivid incandescence. Dry copper oxide is also without action on sulphur trioxide. Purified and dried lime does not decompose dried ammonium chloride, which may be sublimed from the mixture without evolving any ammonia. Purified and dried nitric oxide gives no brown fumes with dried oxygen, but a trace of moist air causes them to appear at once. A mixture of purified and dried hydrogen and chlorine can be exposed to daylight for four days without more than three-fourths of the gases combining. Ammonium chloride, heated in a vacuum in a soft glass tube, leaves a residue of ammonia gas; but when dried and heated in a hard glass tube, no gaseous residue is obtained. This led to the investigation of the vapour density of dry ammonium chloride, which was shown to be normal, 28·7 being the mean result of six experiments. With regard to the theory of the subject, the author believes that an electrochemical hypothesis is applicable. Separation of dried ammonia and hydrogen chloride gases takes place when plates with opposite electrical charges are introduced into the mixture though the action cannot be electrolytic, since discharge is, under the circumstances, impossible. Similar separation was noticed with air and with a mixture of dried hydrogen and oxygen. Electric discharge, when not of high tension, will not pass in dried gases; but the high-tension discharge does pass, and renders it possible for the low-tension discharge to pass afterwards. With regard to the influence of moisture, it appears that what holds for chemical combination holds also for electrical discharge, and that there is great significance in the apparent similarity in the two cases.

Discussion.

The President spoke of Mr. Baker's results as of great value and as calculated to convince all of the important influence exercised by moisture in promoting very many chemical changes; he had long been satisfied that the presence of an electrolyte was essential to every chemical change, and that water was of service because it gave rise to an electrolyte. It was now important to ascertain whether other substances besides water could condition the formation of electrolytes and thus co-operate in producing change, and to determine what their nature was; probably water was one of very few substances able to act in this manner, if indeed it were not the only one. In the case of hydrogen and chlorine, there was reason to think, as Mr. Shenstone had indicated, that some substance other than water was also essential to the occurrence of change.

He was glad to hear Mr. Shenstone say that he was not yet satisfied that pure oxygen can be ozonised; his statement that more ozone was obtained from dried oxygen might be regarded as evidence that water influenced its formation; the amount of ozone finally obtained depended on the amount destroyed as well as on the amount originally formed, and if both its formation and destruction were influenced by moisture, it might well be that one action was more directly influenced than the other when but very little moisture was present. If the destruction took place the less rapidly the less water present, the amount finally obtained would be the greater the more carefully the oxygen was dried.

Regarding the decomposition of ammonium chloride by heat, although moisture would promote its decomposition, the absence of moisture would not have the effect of making it a stable substance at all temperatures; it might be expected that, if dry, it would *decom-*

pose when heated sufficiently, but would not *dissociate;* in other words there would be no re-formation of ammonium chloride under such conditions.

Mr. SHENSTONE was glad to find that Mr. Baker's results had confirmed his own earlier experiments on the production of ozone from oxygen and on the action of ozone on mercury. At the same time he was not yet himself convinced that really dry oxygen would ozonise, and he was at present studying the influence of moisture on the formation of ozone from oxygen quantitatively. He expected the character of the curve obtained would settle the question.

He could also, from the results of many experiments, confirm Mr. Baker's statements as to the persistent activity of highly dried chlorine towards certain substances. Its action on mercury, for example, was often apparently independent of dryness. In fact, the results obtained pointed to the presence of some other substance than water, as being able to influence the action of these two substances. This had led him to search for a more satisfactory source of chlorine.

*18. "New volatile compounds of lead sulphide." By J. B. Hannay.

Early experimenters, notably Pattinson, Regnault, and Jordan, have noticed the volatilisation of lead sulphide in water vapour and its subsequent crystallisation, but their results in other respects seem to be irreconcilable.

An investigation showed that all the phenomena described are easily understood, on the supposition that both water and sulphur dioxide tombine at high temperatures with lead sulphide, forming gaseous compounds. When difference of temperature is taken into account, it is found that water vapour reacts with lead sulphide in the following manner.

1. About 750°........ $PbS + H_2O = PbO{\cdot}H_2S$
2. ,, 900°........ $2PbO + 2PbS = 3Pb + PbS_2O_2$
3. ,, 1400°........ $PbS + H_2O = PbS{\cdot}H_2O$

Neither of the first two changes is complete, but in each the sulphide is decomposed. In the third reaction, however, there is no decomposition, and the sulphide is redeposited on cooling. Reasons are adduced for the conclusion that a definite molecular compound $PbS{\cdot}H_2O$ exists.

Similar indirect evidence is given to demonstrate the existence of the compound PbS,SO_2, or PbS_2O_2. Both these compounds are colourless gases at a red heat, but when the temperature falls decomposition occurs. This remarkable fact is explained by the observation that the oxygen of sulphur dioxide and of water displaces the sulphur of the lead sulphide temperatures near 800°, whilst at higher temperatures, such as 1400°, both sulphur dioxide and water combine with lead sulphide, and redeposit it on cooling.

Discussion.

After remarking that the subject brought forward by Mr. Hannay evidently gave abundant opportunity for discussion, the President said that, assuming that a volatile compound of the formula $PbS{\cdot}SO_2$ existed at high temperatures, the properties assigned to it by Mr. Hannay were not of the unique character he appeared to suggest; numerous cases were recorded of compounds which underwent change as the temperature fell, but probably this was due, not to their intrinsic instability, but to the tendency of such molecules to interact among themselves. At high temperatures lead sulphide might consist of simple (di-atomic) molecules capable of combining with those of other substances, while at lower temperatures such molecules might associate, forming galena, which probably was a polymeride of the compound PbS. The extrusion of oxygen from molten silver and of carbon dioxide on freezing soda water, might be regarded as cases comparable with those brought forward by Mr. Hannay, and such an explanation would apply to them.

Professor Roberts-Austen said that the metallurgy of lead presented many peculiarities. One of these is the necessity of condensing volatile products of the reactions which had led smelters of lead ores to construct condensing flues which might reach a mile in length. The author of the paper would, therefore, be doing good service if he added to our knowledge of the condensible products formed during lead smelting. But the question arose, Had the author of the paper established the fact that water vapour and sulphurous anhydride really carry away sulphide of lead in molecular proportions? There are, as the President had said, many instances of compounds which are stable at a high, and unstable at a low, temperature, and this is a point in Mr. Hannay's favour, but the extreme solvent action of litharge itself must not be forgotten, and litharge, moreover, absorbs oxygen when fluid, and evolves it again on solidification; the effects observed by Mr. Hannay may, therefore, be in some way connected with the solvent action of litharge. It appeared to the speaker that the evidence given by the author of the paper as to the existence of volatile compounds of sulphide of lead and sulphurous anhydride were of the most slender description. If it were possible to obtain evidence as to the vapour density of the volatile products, that would, of course, settle the question, but the author's main evidence appeared to rest on observations made by looking along a red-hot tube, and recording whether certain vapours did or did not form as the temperature is varied. It appeared that Mr. Hannay had not even satisfied himself that when the alleged compounds are cooled down and become unstable they yield their constituents in exactly the proportions demanded by his theory. The evidence afforded by the composition of the "lead fume" which accumulates in the condensing flues is not without importance, but, upon this point, Mr. Gowland would state the results of his experience. Professor Austen gathered that Mr. Hannay objected to the accepted equation $PbSO_4 + PbS = 2SO_2 + 2Pb$, on the ground of the comparative infusibility of the sulphide and sulphate of lead, but it must be remembered that many substances interacted by "fritting" at temperatures well below their melting point. Percy's statement as to the separation of lead, under the conditions represented by the equation, was very definite, and Dr. Percy was very careful, and did not make such statements except on the clearest experimental evidence. The action is, however, an endothermic one, and it would certainly be well to re-examine the conditions with great care. Assuming that the accuracy of the accepted equation $PbS + 2PbO = 3Pb + SO_2$ (which is less endothermic than the first) can be maintained, surely the fact that lead is the result of the reaction, points to the instability at a red heat of Mr. Hannay's compound of sulphide and oxide of lead. Lead sulphide and lead oxide had long been known to be volatile at moderate furnace temperatures, and chemists must certainly have more evidence than that now presented to them before they could accept Mr. Hannay's conclusions.

Mr. GOWLAND did not think that Mr. Hannay had given us sufficient proof that a substance of the formula PbS_2O_2 exists; he does not appear to have isolated it, neither has he shown adequate grounds for regarding it as a product of the smelting of lead sulphide.

The conditions of Mr. Hannay's experiment are not similar to those which occur in the reverberatory furnace in actually smelting lead sulphide. It is generally admitted that the two compounds formed in this operation, viz., lead oxide and sulphate, are volatile in a current of air (see Percy's *Metallurgy of Lead*, pp. 15—42), and that these substances are the chief constituents of the volatile products condensed in the flues of the smelting furnace.

Again, if the lead lost by volatilisation is volatilised as PbS_2O_2, the volatile products which are condensed in the flues as "lead fume" should consist mainly of it, or of the product of its decomposition—lead sulphide. This is, however, not borne out by analyses of "lead fume." In a typical specimen, analysed in Percy's laboratory, the lead, sulphur, and oxygen existed in the following proportions: Pb, 68·47 per cent.; S, 11·25 per cent.; O, 20·28 per cent., whereas, if the fume had consisted of PbS_2O_2, or its products of decomposition, these proportions should have been Pb, 68·32; S, 21·12; O, 10·56, or Pb, 86·61; S, 13·39, or some intermediate proportion.

Until further proof of the existence of PbS_2O_2 has been obtained, we have not sufficient grounds for setting aside the old explanation of the chemistry of lead smelting as set forth by Percy and other distinguished metallurgists.

Mr. A. G. BLOXAM stated that some recent experiments at the Goldsmiths' Institute had shown that galena could be volatilised in both hydrogen and nitrogen. The mineral was heated in a porcelain tube situated in a furnace very similar to that depicted by Mr. Hannay, so that it seemed fair to conclude that the temperature attained was approximately the same as that at which Mr. Hannay worked. The gases were purified by passage through (1) silver nitrate solution, (2) alkaline permanganate solution, (3) red-hot copper, and (4) columns of quicklime and of phosphorous pentoxide. The text-book statement that galena could be volatilised in hydrogen, forming some hydrogen sulphide, was confirmed. In the case of heating in nitrogen, large crystals of galena were afterwards found in the cooler part of the tube, and a sublimation of sulphur was noted.

Mr. HANNAY said, in reply to Professor Roberts-Austen, that the discussion showed how much this difficult subject required to be considered before a true appreciation of the evidence could be arrived at. The last experimental work on the subject was done in 1830. As to the evidence establishing the existence of the compounds being insufficient, a study of the paper would show that all the reactions are quite definite, and that the analysed CO agree with the composition given.

The paper did not deal with lead smelting, and some of the diagrams exhibited merely showed the part played by the new volatile compound in certain reactions.

In reply to Mr. Gowland, Mr. Hannay pointed out that lead sulphate is not volatile at the temperature of the smelting furnace, and that the flue-dust, to which reference was made, was simply the product of oxidation (or partial oxidation) of the volatile compound PbS_2O_2, which is formed in the furnace. As PbS_2O_2 decomposes on cooling, it is useless to look for it in the flue-dust; we only find its products of decomposition. It would be very difficult to determine its vapour density.

The speakers in the discussion seemed inclined to adhere to the old equation $PbS + O_2 = Pb + SO_2$; but this equation seemed to be only hypothetical, and unsupported by experimental proof. As the subject evidently required further elucidation, Mr. Hannay promised to prepare a paper dealing minutely with this part of the metallurgy of lead.

In reply to Mr. Bloxam, Mr. Hannay stated that it is quite true that minute quantities of lead sulphide are volatilised by all gases, but the action of water and sulphur dioxide brought about a sudden and copious evolution of fumes, and the composition of these fumes could be represented by a definite molecular proportion.

19. "Notes on the cupellation of bismuth-silver alloys." By Ernest A. Smith, Assoc. R.S.M.

The loss of silver in the cupellation of lead-silver alloys has been the subject of a large number of experiments at various times, but comparatively few results have been published on the loss of silver in the cupellation of bismuth-silver alloys. A series of experiments was made some years ago by Mr. Hambly (*Chem. Gaz.*, 1856, pp. 185—6) on the cupellation of lead-silver alloys, which prove that, according to the decrease of weight of the silver cupelled, so the loss of that metal very slightly increases, provided the ratio of lead employed be constant. His results also confirm the fact that an increasing ratio of lead produces an increasing loss of silver.

The present experiments were made to ascertain whether the loss of silver by cupellation was the same when varying quantities were employed with a constant ratio of bismuth in the place of lead, and also to find the loss of silver when cupelled with a gradually increasing ratio of bismuth.

The bismuth and the silver employed were specially purified.

The temperature was slightly lower than that usually adopted in the cupellation of lead-silver alloys.

Mr. Hambly concluded that, provided a constant ratio of lead and silver be employed, the loss of silver very slightly increases according to the decrease in the weight of the silver cupelled.

The author finds that a very much greater loss takes place under the same conditions when bismuth is present instead of lead, although the ratio of the loss appears to be about the same.

The results confirm the fact, already known, that an increasing ratio of lead or bismuth produces an increasing loss of silver, the loss, however, being very much greater in the case of bismuth.

As the loss of silver by volatilisation during cupellation is altogether inconsiderable, unless the temperature at which the operation has been conducted has been much too high, the loss is evidently due to the fact that silver is absorbed by the cupel.

20. "Azo-p-cresol derivatives." By R. Meldola, F.R.S., and F. Southerden.

The reduction of the acetyl-derivatives of oxyazo-compounds of the ortho-series has been shown to give ambiguous results so far as concerns the question of the constitution of these compounds (Meldola, Hawkins and Burls, Trans., 1893, 923). An attempt was therefore made to solve the problem by the more direct method of decomposing the acetyl-derivatives by means of nitric acid or bromine. In the case of the alkyl-derivatives of benzeneazo-β-naphthol, the nitric acid method gave a definite indication that the alkyl group is hydroxylic and not amidic (Meldola and Morgan, Trans., 1889, 608). In the case of the acetyl-derivative of benzeneazo-β-naphthol, nitric acid appears to act simply as a nitrating agent (*ibid.*, 609). We have applied the same method to some ortho-azo-derivatives of *p*-cresol, and the results are submitted in the present note.

Paratolueneazo-*p*-cresol was prepared and acetylated (Nölting and Cohn, *Ber.*, 1884, 354). The acetyl-derivative, on reduction with zinc dust on acetic acid, gave, as the only definite product, acetoparatoluide. Acetamido-*p*-cresol may have been formed, but lost by oxidation during the treatment necessary for the isolation of the acetoparatoluide. Resinous colouring matters are formed during the evaporation of the solution by the oxidation of some unstable compound resulting from the reduction. The original compound (paratolueneazo-*p*-cresyl acetate) is brominated by the action of bromine, but the azo-group is not split off and no separation of the molecule takes place, as, *e.g.*, in the case of benzeneazo-β-naphthylamine.

Benzeneazo-*p*-cresol was acetylated (Nölting and Cohn, *Ber.*, 1884, 353) and the product, dissolved in glacial acetic acid, was allowed to stand for two or three days with an excess of bromine. A crystalline substance slowly formed, which, after repeated crystallisation from glacial acetic acid and finally from alcohol, formed golden-brown needles with a silky lustre, melting at 168°. Analysis proved the compound to be a dibromo-derivative of benzeneazo-*p*-cresol. Calculated for $C_{13}H_{10}Br_2N_2O$; Br, 43·24 per cent., N, 7·57 per cent. Found, Br, 43·50 and N, 7·64 per cent.

The acetyl-group thus splits off under the influence of bromine; the azo-compound simply becomes brominated, and, as no separation of the molecule takes place, the products were not further investigated.

Parachlorobenzeneazo-*p*-cresol was prepared in the usual way by mixing a solution of diazotised parachloraniline with an alkaline solution of paracresol. The product, when purified by crystallisation from alcohol and benzene in succession, forms flat, golden-orange needles, melting at 155°. The compound appears to exist also in another crystalline form, as the rapid evaporation of the benzene solution gives rise to a deposit of small, opaque, ochreous needles, having the same melting point. The purity of the compound was ascertained by analysis. Calculated for (*p*) $Cl{\cdot}C_6H_4{\cdot}N_2{\cdot}C_6H_3(CH_3){\cdot}OH$ $[N_2 : CH_3 : OH = 6 : 4 : 1]$; Cl, 14·43 and N, 11·36 per cent. Found, Cl, 14·46 and N, 11·45 per cent.

The acetyl-derivative was prepared by boiling the foregoing compound with excess of acetic anhydride for about 20 hours. After crystallisation from alcohol, it forms orange needles, melting at 120°.

Calculated, Cl, 12·31 and N, 9·61 per cent. Found, Cl, 12·46 and N, 9·78 per cent.

As bromine had acted on these compounds merely as a brominating agent, the substance was acted upon by nitric acid of various strengths and under various conditions. Nothing of the nature of a nitrated aniline, acetanilide, amido- or acetamido-cresol was, however, obtained Nitric acid appears to nitrate the azo-compound as a whole, forming a yellow, uncrystallisable product, apparently of the same nature as that resulting from the nitration of benzeneazo-β-naphthyl acetate (Trans., 1889, 609).

21. "Effect of heat on iodates and bromates." By Ernest H. Cook, D.Sc.

This paper is the first instalment of an account of the experiments made upon the effect of heat upon iodates and bromates. It deals with potassic iodate and bromate. Details are first given of the methods of purification of the reagents used. Exceptional difficulties were experienced with potassium iodide, and the ordinary methods of purification adopted were shown not to yield a sufficiently pure product. The paper of Robineau and Rollin (*J. Pharm.* [5], **26**, 485—490), in which they state that "all acids, even carbonic anhydride in presence of air and moisture, decompose potassic iodide," is quoted, and a series of experiments to test the truth of this statement are detailed. The results obtained show that the statement is only partly true.

The methods adopted for the analysis of the oxy-salts are then given. These were of three kinds:—(1) Digestion with potassic iodide and hydrochloric acid; (2) reduction by sulphurous acid; and (3) reduction by the copper-zinc couple. These methods are compared and the precautions necessary for success are stated. In the first it is shown that accurate results can only be obtained when a blank experiment with potassium iodide and hydrogen chloride is carried on side by side with the principal one.

Potassic iodate is difficult to purify; repeated crystallisations from water fails to give a reliable product. The method adopted was, therefore, to crystallise from water once or twice, then to precipitate the solution by means of alcohol, collect the precipitate and recrystallise from water. The first effect of heat on the iodate is to cause the substance to become brown. This brown substance has the same composition as the original iodate, and it is formed without any alteration taking place in weight. When the heating of the iodate is continued up to the time of its ceasing to lose weight, the following changes are observed: the brown substance fuses and becomes a colourless liquid, during the fusion, iodine is evolved; after continued and regulated heating, the liquid becomes a white solid, and when thoroughly solid, ceases to lose weight; the residue is potassium iodide.

The next point studied was the partial decomposition of the iodate. The salt was heated for varying periods, the amount of loss ascertained, and the residue analysed. The results showed that no other oxy-compounds were formed at any stage of the process.

Potassium bromate was next experimented with, the total decomposition of the salt by heat as well as the partial decomposition being studied. No change of colour occurs with the bromate, but the salt decrepitates at about 180° C. During the decrepitation bromine is evolved, but at no other stage of the process. The salt fuses to a colourless liquid, from which oxygen is steadily evolved; the residue consists of potassium bromide.

The partial decomposition indicated the presence of breaks in the rate of evolution of the oxygen; these were shown to be due to the mode of heating, and not to definite chemical reactions. The residue consists of a mixture of bromate and bromide.

These experiments having failed to produce any oxy-compounds, it was thought that these compounds might be formed if the heating were effected under reduced pressure; but at a pressure of 30 mm. the results were precisely the same as under normal conditions.

Finally, in order to discover at what stage the chlorine known to be evolved when chlorate is heated is produced, experiments were made with that substance. It was found that the chlorine was evolved just at the same period as the iodine from the iodate, viz., during the melting of the salt. The amount formed is 0·03 per cent.

It would, therefore, appear that the halogen is liberated early, but that it is not actually set free until the structure of the salt is broken down—in the case of the iodate by fusion, and in that of the bromate by decrepitation.

ADDITIONS TO THE LIBRARY.

I. *Donations.*

Engineering Chemistry; comprising Methods of Analysis and Valuation of the Principal Materials used in Engineering Work. By H. J. Phillips. London 1894. From the Author.

Transactions of the Sanitary Institute. Vol. XIV, 1893. London 1893. From the Institute.

Rothamsted Jubilee Fund. Report of the Executive Committee; with an Account of the Proceedings at the Commemoration of the Jubilee of the Rothamsted Experiments, July 29th, 1893. London 1894. From the Committee.

Pamphlets from the Authors.

Ueber colloidales Gold, von P. Schottländer (Verh. Gesells. deut. Naturforscher u. Aertzte). Nürnberg 1893.

De l'Emploi du Sulfate de Magnésie comme Engrais. Par E. Silz. Paris 1890.

RESEARCH FUND.

A meeting of the Research Fund Committee will be held in June. Fellows who desire grants are requested to send in their applications to the Secretaries at Burlington House, not later than Tuesday, June 5th.

At the next meeting of the Society, on Thursday, June 7th, 1894, there will be a ballot for the election of Fellows, and the following papers will be read:—

"The nature of phosphorescence." By Herbert Jackson, B.Sc.

"The crystallography of the normal sulphate of potassium, rubidium, and cæsium." By A. E. Tutton.

"The boiling points of homologous compounds. Part II." By Dr. James Walker.

CERTIFICATES OF CANDIDATES FOR ELECTION AT THE NEXT BALLOT.

June 7th, 1894.

N.B.—The names of those who sign from "General Knowledge" are printed in *italics.*

Dixon, George,

Trinity College, Cambridge.

Research Student. B.A. Trinity College, Cambridge. Honours in Natural Sciences, Tripos, 1893. Assisting Messrs. Easterfield and Sell in investigations upon the derivatives of pyridine.

W. J. Sell. T. H. Easterfield. J. T. Hewitt.
Alexander Scott. H. J. H. Fenton.

Donald, George,

Arnold Printworks, North Adams, Mass., U.A.

Printworks' Chemist. Three years a bursar in the Young Laboratory, Glasgow; nine months Chemist in Loch Katrine Distillery, Glasgow; four years Chemist in Lennoxmill Printworks, by Glasgow; eight years Chemist in Arnold Printworks. Joint author (with Professor Mills) of a paper "On the Action of Oxides on Salts" (*Chem. Soc. J.*, **41**, 1882, 18).

Edmund J. Mills. A. G. Perkin.
Wm. McD. Mackey. Archibald Walker.
A. Humboldt Sexton.

Eumorfopoulos, Nicholas,

1, Kensington Park Gardens, W.

Student. Student in University College. B.Sc. University of London.

William Ramsay. J. Norman Collie.
James Walker. John Shields.
Temple Orme. Morris W. Travers.

Flintoff, Robert John,

Haxby. Crumpsall Lane, Crumpsall, Manchester.

Printworks' Chemist. Educated at the Manchester Grammar School and Owens College, worked in Professor Dixon's Laboratory, and with Mr. Ernest Bentz, Lecturer on Technical Chemistry. On leaving college was appointed Chemist to Messrs. T. and D. Southern, Manufacturers of sulphuric, hydrochloric, and nitric acids. Afterwards became Chemist to Messrs. Grimshaw and Bros., Limited, and in that capacity worked on the purification of sewage and waste effluents, also on the manufacture of the basic per. salts of iron. Am now Chemist at Messrs F. Scott and Co., Calico Printers, Littleboro', and am engaged at present upon the production of "azo" colours directly upon the fibre.

Harold B. Dixon.
Francis Jones.
Arthur Harden.
Gilbert J. Fowler.
Harry Grimshaw.
G. H. Bailey.
P. J. Hartog.
W. H. Perkin, jun.

Hadley, Arthur,

226, Monument Road, Edgbaston, Birmingham.

Brewer and Brewer's Chemist, at Mitchell's Brewery, Cape Hill, Birmingham. Honours in Chemistry, Science and Art Examination, and other passes. Honours in Brewing, City and Guilds Examination, 1892 and 1893. Student at Mason's Science College, Birmingham, and Institute; also Birmingham Municipal Technical School for some years.

William W. Butler
Geo. E. Perry.
W. Duncan, F.I.C.
Alfred Senthall.
Jno. W. Alcock.
Thomas Edwards.
H. J. Mousley.
G. T. Evans.

Harris, Sydney Walters,

15, Lansdowne Terrace, Walters Road, Swansea.

Analytical Chemist. Six months studying the analysis of steel in the Laboratory of the Forest Steel Works (Messrs. Wm. Williams & Co.). Subsequently four years with Dr. Wm. Morgan, a Fellow of your Society, and Public Analyst of Swansea, &c., undergoing a course of Analytical Chemistry in all it branches. Am now, and have been for the last two years, engaged as Analytical Chemist and Assayer with Messrs. Richardson & Co., Mineral Importers of this town.

Wm. Morgan.
Rhys. P. Charles.
Otto Hehner.
W. Terrill.
Arthur Luty.
Frank B. Last.

Hitchens, J. H.,

North Devon Lodge, Cheltenham.

M.A. Oxon., Senior Science Master at Cheltenham College, late

Scholar of Queen's College, Oxford; Honours in final Art Science School, Burdett-Coutts Scholar, late Science Master at St. Peter's College, Radley.

W. A Shenstone. W. W. Fisher.
J. A. Gardner. D. H. Nagel.
J. E. Marsh.

Holt, Wilmot, jun.,

The Park, Didsbury, Manchester.

Research Student in the Owens College. For four years Student of Chemistry at the Owens College, having completed course for Degree in the Honours School of Chemistry. Recently published "Behaviour of the Alkali Metals under Oxidation" (jointly with W. E. Sims).

Harold B. Dixon. W. H. Perkin, jun.
Arthur Harden. G. H. Bailey.
Arthur W. Crossley. Gilbert J. Fowler.

Hope, Arthur Peach,

Salisbury Road, Leicester.

Analytical Chemist. Member by examination of the Pharmaceutical Society. Has devoted special attention to the purification of sewage and kindred subjects, particularly the analytical and bacteriological examination of water in its relation to sewage contamination. Author and patentee of Hope's Bacilli Sewage Purification Process now running at Kettering and other towns.

Percy F. Frankland. J. W. Slater.
Edward D. Gravill. Wallace C. Nickels.
T. A. Ellwood.

McLeod, James,

2, Gladstone Terrace, Paisley.

Chemist's Assistant. Four years Lecture Assistant to Mr. Charles Manners, jun., F.I.C.; Analytical Chemist, Lecturer on Chemistry, &c., Paisley. Five years nine months Assistant in Laboratory of Messrs. J. and P. Coats, Limited, Thread Manufacturers, Paisley.

G. G. Henderson. James Robson. Aug. Schloesser.
Thomas Gray. A. Humboldt Sexton.

Newth, G. S.,

29, Mount Park Road, Ealing, W.

Demonstrator Royal College of Science, South Kensington. Late Lecturer on Chemistry, New College, Hampstead, and Princess

Helena College, Ealing. Author "Newth's Chemical Lecture Experiments."

T. E. Thorpe. W. Palmer Wynne.
Chapman Jones. Henry E. Armstrong.
Wyndham R. Dunstan. John M. Thomson.

Nixon, Alfred,

14, Entwistle Street, Moss Side, Manchester.

Principal of the Central Commercial Evening School, University and Special Classes. Lecturer to Teachers' Classes and Higher Grade Schools (Science Departments). Lectures and Practical Work in Mr. Rothwell's Classes, under Sir H. Roscoe at Owens College, and in Materia Medica and Pharmacy at Owens College. Passed the 1st M.B. examination (equivalent to 1st B.Sc.) of the Victoria University in Chemistry, Biology, and Physics. Written and practical work in all subjects.

C. F. Seymour Rothwell. Robt. R. Rothwell.
R. L. Taylor. *George H. Hurst.* *Joseph Morris.*

Parker, G. L.,

The Paddocks, Eccleston, Chester.

Mining Engineer and Assayer. Pupil in Laboratory of W. F. Lowe, Assay Office, Chester; also studied at the Camborne School of Mines, Cornwall. Assayer and Engineer to the Mashonaland Gold and Land Company.

W. F. Lowe. John Bairstow. G. Watney Webster.
Edward Kinch. *A. J. Greenaway.* *J. Carter Bell.*

Pike, E. Brooke,

6, Lathom Road, East Ham.

Chemical Assistant at the Northern Outfall Precipitation Works, Beckton, E. For two years a pupil of Dr. Dupré, F.R.S. For four and a half years an Assistant in the Chemical Department of the London County Council under Mr. Dibdin, F.I.C., F.C.S.

A. Dupré. W. J. Dibdin. H. Wilson Hake.
Frederic Jas. M. Page. Alfred G. Pike. *John M. Thomson.*

Robjohns, Herbert Harold,

King's School, Pontefract, Yorks.

Science Master King's School, and Science Master Town Technical School, Pontefract, 1887—90. Student in Chemical Laboratories, University College of Wales, Aberystwyth, 1891. Lecture Assistant to Professor of Chemistry, U.C.W., 1892 onwards, as above. Science Master at King's School, &c. B.Sc. London.

H. Lloyd Snape.	Arthur W. Warrington.
Leonard T. Thorne.	*Frank Woodward Branson.*
W. J. Russell.	*F. D. Chattaway.*

Rolfe, John F.,

Homewood, Leytonstone, Essex.

Analytical Chemist. Studied in the Laboratory at University College under Professor Graham, during the Session 1888—89, and during the same year attended courses of lectures. Worked for three years since as a student, and during the last two years as Assistant under Dr. Graham and Mr. Chapman. Have had considerable experience in chemical work of all kinds.

Charles Graham.	Alfred C. Chapman.
Charles J. Wilson.	*William Ramsay.*
John Norman Collie.	*James Walker.*

Ryce, George,

Rathmore Place, Cork.

B.A. Royal University, Ireland. Analytical Chemist. Has studied Chemistry at Queen's College, Cork, under Professor Maxwell Simpson. Senior Scholar in Experimental Science, Queen's College, Cork. A 1851 Commission Exhibitioner. At present studying Chemistry at the Royal College of Science, South Kensington.

T. E. Thorpe.	W. Palmer Wynne.
William Tate.	Chapman Jones.
A. E. Tutton.	J. W. Rodger.

Shorthouse, Herbert Stephen,

47, Pershore Road, Birmingham.

Chemist and Laboratory Manager for Messrs. P. Harris and Co., Manufacturing and Analytical Chemists, Birmingham. Have for seven years been engaged daily in the manufacture of inorganic and organic chemicals and pharmaceutical preparations, and in analysis of commercial articles. Have passed Iron and Steel Manufacture Examination (City and Guilds). Advanced Practical and Theory Chemistry (South Kensington), Scholarship. Honours Practical Chemistry (Inorganic) 1st Class.

Harry Silvester. Arthur Adams. William W. Butler.
Jno. W. Alcock. Charles Bayliss.

Shuttleworth, Professor Edward B.,

Lecturer on Materia Medica, Trinity Medical College, Toronto.

Formerly a pupil of Professor Sullivan and Sir Robert Kane, Dublin. Doctor of Pharmacy, Trinity College, Toronto. Lately Professor of Chemistry and Dean in the Ontario College of Pharmacy. Was for 10 years Chairman of the Board of Examiners, Ontario College of Pharmacy. Have been Editor of the *Canadian Pharmaceutical Journal* for 25 years. Author of "Preparation of Dialysed Iron" (1878), *Canadian Pharmaceutical Journal and Year Book.* "Lithium Benzoate" (1875), *Canadian Pharmaceutical Journal and Year Book.* "New Mode of Preparing Ferric Salts" (1879), *Canadian Pharmaceutical Journal and Year Book ;* etc.

John Attfield. W. H. Ellis.
W. H. Pike. J. Bemrose.
Wyndham R. Dunstan. *G. P. Girdwood.*
J. Baker Edwards.

Smith, Ernest Alfred,

17, Oval Road, Regent's Park, N.W.

Metallurgist. Assistant Instructor in Assaying, Royal School of Mines, London. Associate of Royal School of Mines. London Honours Medallist, Science and Art Department. Late Chief Assistant to B. Kitto, Esq., F.G.S., F.I.C., Analyst, 30—31, St. Swithin's Lane. Late Lecturer on Metallurgy and Instructor in Assaying, Royal College of Science, Dublin. Member of Society of Chemical Industry. Author of paper on "Presence and Estimation of Gold and Silver in Antimony and Bismuth."

T. E. Thorpe. N. C. Roberts-Austen.
W. Palmer Wynne. Bennett H. Brough.
William Tate.

Spenzer, John George, M.D., Ph.D.,

Cleveland, O., U.S.A., 370, Central Avenue.

From 1880—1884 and 1886—1887 Assistant in Chemistry to the Medical Department; from 1884—1887 Assistant in Chemistry to Literary Department (Adelbert College) of Western Reserve University, at Cleveland, Ohio; from 1887—1891 practising Physician; from 1891 to the present, Student of Chemistry at the Strassburg University; from 1881—1891 contributions of Chemical, Pharmaceutical, or Medical interest, read before and published in the Proceedings of the American A.A. Science Amer. Pharm. Assoc.; Ohio State Pharm. Assoc.; and Ohio State Microscopical Society.

D. R. Fittig. C. F. Baker.
Dr. H. C. Myers. *Robert Hellon.*
Archibald Kitchin. *Herbert Ingle.*
J. B. Cohen.

Steel, Robert W.,

Wedderburn, Paisley.

Chemist. Four years' College training in Anderson's College, Glasgow, under the late Professor Dittmar, and latterly Professor Henderson. Over one year and six months with Messrs. J. and P. Coats, Limited, Thread Manufacturers, Paisley.

G. G. Henderson. James Robson.
Aug. Schloesser. Thomas Gray.
A. Humboldt Sexton.

Taylor, Herbert John,

Fern Villa, 33, Russell Street, Eccles, near Manchester.

Teacher of Chemistry. Two years Laboratory Assistant and Teacher of Chemistry at the Central Hr. Gd. Bd. School, Manchester. Student at the Manchester Technical School and Owens College (Evening Classes). Two years Teacher of Chemistry at the Astley Institute, Dukinfield (Evening Classes). Two years Student in Chemistry at the Normal School of Science, South Kensington. At present, and during the last four years, Assistant Science Master at the Central Higher Grade Board School, Manchester.

T. E. Thorpe. R. L. Taylor.
Francis Jones. William Burton.
S. Parrish.

Thompson, Edward Cumming,

5, Gubyon Avenue, Herne Hill, S.E.

Manufacturing Chemist. Chemist at Messrs. F. C. Hill and Company's Chemical Works, Deptford. Associate of the Royal College of Science, London, in Chemistry (1st Class). Engaged in research work under Professor Thorpe, F.R.S., for six months. 1st Class Honours in Chemistry at Intermediate Science Examination, London University.

T. E. Thorpe. W. Palmer Wynne
J. W. Rodger. A. E. Tutton.
William Tate. W. A. S. Calder.

Thudichum, George Dupré,

Montrose, Dorset Road, Merton Park,

Assistant in the Chemical and Gas Department of the London County Council. For ten years engaged in experimental work in connection with sewage treatment and allied subjects, under the direction of the Chemist to the Metropolitan Board of Works and the London County Council. Formerly assistant with Dr. Dupré.

J. L. W. Thudichum, M.D. Dibdin, W. J.
A. Dupré. Frederic Jas. M. Page.
R. Grimwood. Wm. Jno. Livingston.

Walker, Charles H. H.,

Prospect Place, Cainscross]
Master. B.A. Oxford. 1st C!
istry) 1893. Science Master at
Lecture Assistant, Chemical Depa
ducts of the Action of Nitric Acid

W. W. Fisher. W. H.
J. E. Marsh. John \

Waterfield, Arthur Swainson,

The Grammar School, Beve
Science Teacher. M.A. Oxon.
Science Teacher at Guildford, .
Lecturer. Now employed by the]

John Watts. W. W. :
V. H. Veley. *D. H. N*

Wright, Robert,

11, Eagle Parade, Buxton.
Pharmaceutical Chemist. As a
Pharmaceutical Society, took Med
Certificate of Honour in General
lished twenty-eight notes and pap
Chemical Science.

John C. Thresh. John At
W. A. H. Naylor. Wm. M
M. Conroy.

HARRISON AND SONS, PRINTERS IN ORDIN

Issued 19/6/1894.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

No. 140 Session 1893-94.

June 7th, 1894. Dr. Armstrong, President, in the Chair.

Certificates were read for the first time in favour of Messrs. Henry Spencer Blacmore, 206, South 9th Avenue, Mount Vernon, New York; Joseph F. Chambers, Grammar School, Dursley, Gloucester; William Dixon, 102, Spring Street, Bury, Lancashire; Frederick Dunn, 83, Packington Street, Kew, Melbourne; Martin Stanyer Higgs, Clarence House, Gloucester; James Knight, 121, Kenmure Street, Pollockshields, Glasgow; Charles Stirling Saunders, 163, Victoria Street, Westminster; Cuthbert Vaux, 11, Thornhill Park, Sunderland; John Cundell Wood, 3, Bedford Terrace, Sunderland.

The following were duly elected Fellows of the Society:—George Dixon, George Donald, Nicholas Eumorfopoulos, Robert John Flintoff, Bhikaji Edalji Ghasvala, Arthur Hadley, Sydney Walters Harris, J. H. Hitchens, Wilmot Holt (Jun.), Arthur Peach Hope, James McLeod, G. S. Newth, Alfred Nixon, G. L. Parker, E. Brooke Pike, Herbert Harold Robjohns, John F. Rolfe, George Ryce, Herbert Stephen Shorthouse, Professor Edward B Shuttleworth, Ernest Alfred Smith, John George Spenzer, M.D., Ph.D., Robert W. Steel, Herbert John Taylor, Edward Cumming Thompson, George Dupré Thudichum, Charles H. H. Walker, Arthur Swainson Waterfield, Robert Wright.

Of the following papers those marked * were read:—

*22. "The crystallography of the normal sulphates of potassium, rubidium, and cæsium." By A. E. Tutton, Assoc. R.C.S.

The author has made a detailed study of the goniometrical and physical characters of the crystals of these three salts, in order primarily to ascertain whether they exhibit any connection with the atomic weight of the metals contained. A very large number of goniometrical measurements were made upon particularly perfect crystals of the pure salts, and the physical measurements were carried out upon a similar scale. The results of the optical investigation have been merely enhanced in accuracy, and the observations themselves greatly facilitated, by the use of the instrument for grinding section-plates and prisms and the apparatus for illuminating the whole field of an optical instrument with spectrum monochromatic light of any desired wave-lengths, recently described by the author (*Proc. Roy. Soc.*, 55, 108 and 111). The main results of the investigation are the following.

1. The normal sulphates of potassium, rubidium, and cæsium exhibit a graduated order of solubility corresponding to the order of the atomic weights of the three metals. Potassium sulphate is very sparingly soluble, cæsium sulphate is extremely soluble, and rubidium sulphate is soluble to an intermediate extent in water.

2. The habits assumed by the strictly isomorphous rhombic crystals of the three salts approach each other very closely, but the predominating relative amounts of development of the primary faces indicate a progression in the order of the atomic weights of the contained metals.

3. The magnitudes of the whole of the angles of the rubidium salt lie between those of the analogous angles upon the potassium and cæsium salts. The angular differences are much smaller than those exhibited by the monoclinic double sulphates previously investigated, indicating that such differences are smaller the higher the symmetry.

4. The axial ratios for rubidium sulphate are intermediate between those for potassium and cæsium sulphates. The ratio $a:b$ diminishes, but only very slightly, upon replacing potassium by rubidium, or the latter by cæsium, while the ratio $c:b$ increases materially. The conclusions in this and the preceding paragraph are independent of the temperature.

5. The relative density, which has been determined with the greatest care upon a large number of samples of the pure salts, and molecular volume of rubidium sulphate, are intermediate between the values of these constants for the potassium and cæsium salts. A greater increase of volume accompanies the replacement of rubidium by cæsium than is observed when rubidium replaces potassium, but the difference is not so large as that derived from Pettesson's determinations of the densities, he having worked with much smaller quantities of the salts, and in the case of cæsium sulphate, with impure material.

6. The coefficients of cubical expansion, derived from determina-

tions of density at higher temperature, are almost identical, the differences being about the limits of experimental error. Determinations of the linear thermal expansion indicate that the greatest amount of expansion occurs in the direction of the vertical axis *c*, the expansion along the other two axes being more nearly equal.

7. The distance-ratios (topic axes of Muthmann) of the crystal-elements (physical molecules), obtained by combining the axial ratios with the molecular volumes, indicate that the replacement of potassium by rubidium and rubidium by cæsium is accompanied by an increase in the separation of the crystal-elements along each of the axial directions, and this increase is relatively much greater when cæsium replaces rubidium than when the latter replaces potassium. The amount of increase is greatest along the *b* axis and least along the *a* axis, but if the amount of increase is considered proportionally to the lengths of the axes, the change along the *c* axis is greater than in proportion to the length of that axis, while the changes along the *a* and *b* axes are almost in exact proportion to their lengths.

8. The directions of cleavage, the positions of the planes in which the elementary parallelograms occupy least area, and the nature of the forms exhibited by the crystals, agree in indicating that the elementary parallelopiped of the series is a rectangular rhombic prism. The order of change in the distance-ratios can be fully accounted for upon the supposition that the crystal-element of the series is composed of four chemical molecules, symmetrically arranged with respect to the three planes of rhombic symmetry.

9. An increase of refractive power accompanies an increase in the atomic weight of the contained metal, and the increase becomes relatively greater as the atomic weight rises. Hence the intermediate refractive indices and optical elasticity constants of rubidium sulphate are nearer to the potassium than to the cæsium salt. The ellipsoidal wave-surface, of rays emanating from a common central point, for rubidium sulphate lies between the wave-surfaces of potassium and cæsium sulphates respectively, and nearer to the outer enveloping wave-surface of the potassium salt than to the inner one of cæsium sulphate.

10. The amount of diminution of optical elasticity on passing from one salt to another is almost identical in the axial directions *a* and *b*, but is much less along the axis *c*. This causes a reversal in the order of double refraction, the potassium salt being endowed with positive and the cæsium salt with negative double-refraction. The intermediate value which the elasticity along the axis *c* assumes in the rubidium salt happens to fall so close to the value along the *b* axis, and between that value and the already closely lying value along the *a* axis, that crystals of rubidium sulphate exhibit extra-

ordinarily low double refraction, and the optic axial angle exhibits very large dispersion for different wave-lengths.

11. A regular decrease in refractive power and corresponding increase of optical elasticity is observed as the temperature is raised. This change is likewise greatest along the *c* axis, and the lesser changes along the *a* and *b* axes are approximately equal. The relations, however, are the same as at the ordinary temperature, rubidium maintaining its intermediate position. The greater change along the *c* axis causes a remarkable alteration in the optic axial angle of rubidium sulphate. A few degrees of rise of temperature are sufficient to bring the value along the *c* axis identical with that along the *b* axis, and afterwards to overstep that value. Hence, before warming a section-plate perpendicular to the first median line, the hyperbolic brushes indicating the loci of the optic axis are observed to approach the centre, and, for the different wave-lengths in succession, owing to the large dispersion, to unite and produce an uniaxial figure. This occurs at about 40° for red light and 65° for violet light. Further heating causes the brushes to separate in the plane at right angles to that which previously contained them.

12. The molecular refraction and dispersion, whether calculated by the formulæ of Lorentz or Gladstone and Dale, increase with the atomic weight of the contained metal, rubidium sulphate being also intermediate in this respect. The increase becomes greater as the atomic weight rises, and proceeds at a slower rate along the *c* axis than along the *a* and *b* axes, along which latter directions the changes are almost identical. These relationships are independent of the temperature.

13. With regard to every property, whether morphological or physical, it has thus been found that rubidium sulphate stands intermediate between the potassium and cæsium salt. The replacement of rubidium by cæsium is generally accompanied by a greater modification of the crystallographical characters, than when potassium is replaced by rubidium, the heavier atom exerting an influence greater than in mere simple proportion to the increase in atomic weight. The comparative results for the different properties are all in line with each other, the relations of the amounts of change along the crystallographic axes being similar with regard to all. Moreover, the progression, according to the atomic weight of the contained metal, is perceptible with regard to the minutest details of the physical phenomena presented by the crystals, and is entirely independent of the temperature. The author therefore finally concludes that—

"The whole of the crystallographical properties of the strictly isomorphous, rhombic, normal sulphates of potassium, rubidium, and cæsium, are functions of the atomic weight of the metal which they contain."

Discussion.

Mr. Miers was of opinion that Mr. Tutton had established the relations between these sulphates with absolute certainty, and had determined their characters with greater accuracy than had ever yet been done for any crystallised series. He believed, however, that all conclusions drawn from the crystal form alone regarding the relative positions of the atoms in the crystal molecule must at present be regarded as nothing more than speculations. Additive relations, as in the Humite group of minerals, where successive additions of the radicle Mg_2SiO_4 produce *equal* changes in the length of one crystallographic axis alone are extremely suggestive; but the method of Muthmann and Mr. Tutton requires us to assume the exact form of the elementary parallelopiped, of which we have no knowledge. If the symmetry of the molecule is supposed to be the same as that of the crystal, we encounter a further grave difficulty in the case of those isomorphous compounds which have nearly the same form and yet belong to different systems; for the replacement of one radicle by another in a symmetrical group should not disturb the symmetry if the arrangement remains the same. Such speculations have yet to be tested by physical characters.

*23. "Observations on the nature of phosphorescence." By Herbert Jackson.

This paper deals, first, with the readiness with which the phenomena of phosphorescence may be studied by using a mechanical pump capable of very rapidly giving high vacua (Fleuss's pump).

The author considers that in many cases the phosphorescence cannot be ascribed to impurities, but that a presumably pure substance yields in several instances phosphorescence of different colours.

The main portion of the paper is occupied with an attempt to show that the phenomena of fluorescence, phosphorescence in air on exposure to light, and phosphorescence of substances in a vacuum under the influence of the electric discharge, are of the same nature, viz., a response on the part of the substances to the operation of radiant energy propagated after the manner of light in undulations of short length.

These undulations proceed from the electrode, and to them the gas in the tube responds, giving rise to the visible light in the gas.

To this light some phosphorescent bodies respond; but others require to be affected by the very short undulations to which air is opaque. Such substances therefore only phosphoresce in high vacua.

These conclusions are based on experiments made with a "jar spark" in air acting upon phosphorescent substances placed in the appropriate foci of a quartz lens; on the study of the behaviour of such substances outside a vacuum tube provided with a quartz window, and also on their behaviour inside the vacuum tube.

The results of a very large number of experiments seem to indicate a close connection between the phenomena of phosphorescence in air and in a vacuum, broken only when the opacity of quartz to some undulations and of air to others interferes.

DISCUSSION.

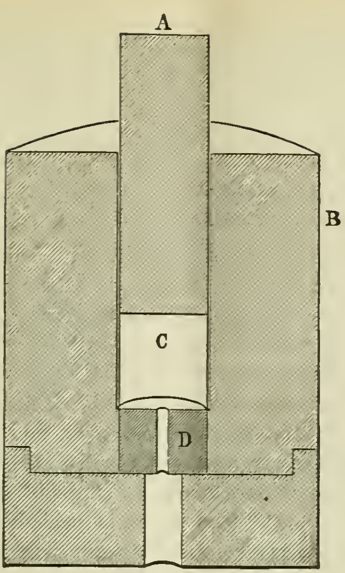
Professor DEWAR stated that he had recently made a series of experiments on photographic action and phosphorescence at temperatures between −180° and −200° C. The majority of substances under such conditions show more or less phosphorescence, and some, like cotton wool, paraffin, the alcohols, ketones, acids, &c., are remarkably brilliant. Substances that at ordinary temperatures are said only to be fluorescent, become phosphorescent owing to the combined effect of greater and differently distributed absorption and the lengthening of the period of dissipation when light rays are emitted.

Mr. JACKSON remarked that he had found the phosphorescence of some substances could only be observed after they had been cooled in solid carbon dioxide dissolved in ether, while in the case of other substances they required first to be raised above the ordinary temperature.

The PRESIDENT pointed out that the great simplification in the method of producing phosphorescence introduced to their notice by the author would much facilitate the study of the spectra of substances phosphorescing in high vacua—a class of spectra which, to judge from Mr. Crookes's researches, were especially valuble in differentiating the rare earths.

*24. "Note on the viscosity of solids." By James Dewar, F.R.S.

The experiments of Tresca on the flow of metals are well known, as are also the observations of Spring on the cohesion of powdered substances under pressure. It appears that few, if any, systematic experiments have been made on the viscous flow of solid salts and organic compounds. The following apparatus was used in the experiments.



B is a strong steel block with a tight-fitting piston of the same metal; the narrow tube through which the substance was squeezed is represented by D, and C is the space filled with the substance. The diameter of the narrow steel tube D was $\frac{1}{16}$ inch and the length $\frac{1}{2}$ inch. In the following experiments the maximum theoretical pressure was 60 tons on the square inch; this being determined from the relation between the diameters of the piston A and that of the hydraulic press used in the experiments, together with the pressure observed in the latter. The easily flowing bodies generally flow above 30 to 40 tons pressure. The substances experimented upon may be divided into two groups: those forming a wire under the conditions, and those which hardly show any trace of viscosity. It is to be understood that each experiment did not last longer than from five to ten minutes on the average. The ordinary hydrated salts are distinguished by the addition of "aq."

Bodies which flow into wire :—Sodium sulphate, aq, sodium carbonate, aq, sodium thiosulphate, aq, magnesium chloride, aq, ferrous sulphate, aq, ammonium chloride, potassium chloride, bromide, iodide, cyanide, nitrates of ammonium, potassium and silver, strontium chloride, aq, aluminium sulphate, aq, caustic soda, oxalic acid, aq, sodium acetate, calcium chloride (slow), acetamide (slow), lead acetate (slow), benzoic acid (slow), graphite (easy, brittle wire), iodine (easy, long continuous wires), urea (easy), anthraquinone (very slow, brittle).

Bodies which do not flow into wire:—Sodium phosphate, aq, borax, aq, alums, sodium nitrate, chloride of sodium, lithium, zinc, mercury, sulphide of manganese aq, ammonium sulphate, sodium oxalate, ferrous oxalate, rochelle salt, arsenious oxide, potassium ferocyanide, sodium acetate, ammonium acetate, aq, nitrates of barium, strontium, caustic potash, dry carbonate and sulphate of sodium, dry sulphide of aluminium, sugar, starch, naphthalene.

Many of these substances explode through the narrow orifice in sudden bursts rather than form any wire, and such a sudden shock has on two occasions caused the fracture of the strong steel cylinder. These preliminary results are sufficient to show that the explanation of the cause of the flow of solid matter in the class of bodies under consideration will require prolonged investigation. No doubt many of the substances which do not flow (or only do so with extreme slowness) at 60 tons on the square inch, may do so at much higher pressures. It would appear, however, that in each case the substance has a limiting pressure which must be reached before a reasonable rate of flow is attained, and this value is probably a constant. The rate of flow of fused sulphocyanide of ammonia at 60 tons is about one inch a minute.

25. "Boiling points of homologous compounds. Part II." By James Walker.

The author has now applied his formula $T = aM^b$ (Trans., 1894, **193**) to the normal fatty acids, their ethereal salts, the normal hydrocarbons, the normal alkyl chlorides, and other series of compounds, and finds that on the whole it gives satisfactory results. The only pronounced exceptions are the series of the alkyl bromides and alkyl iodides.

The formula is valid for the boiling points at pressures other than the atmospheric pressure, the constant a alone varying from pressure to pressure. A deduction from the constancy of b in such cases is that in any homologous series the ratio of the absolute boiling points at two different pressures is the same for all members of the series. This deduction is confirmed by the experimental data.

26. "The action of methyl iodide on hydroxylamine." By Wyndham R. Dunstan, F.R.S., and Ernest Goulding.

In the current number of the *Recueil des Travaux Chimiques des Pays Bas*, M. Lobry de Bruyn gives an account of experiments he has made on the action of methyl iodide on hydroxylamine. He states that when the iodide is mixed either with a solution of free hydroxylamine or with an alkaline solution of hydroxylamine hydrochloride, β-methyl hydroxylamine hydriodide, $CH_3NH \cdot OH,HI$, is readily produced, and separates in crystals from the liquid, so that by this means the compounds of β-methyl hydroxylamine, which have hitherto been troublesome to prepare, are readily obtained in a pure state; and, similarly, it would appear that the process is applicable to the preparation of other β-alkyl hydroxylamines.

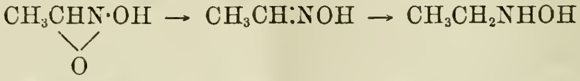
The authors have for some time been engaged in similar experiments also, in the hope of discovering a simple mode of preparing β-alkyl hydroxylamines, but the results they have obtained do not correspond with those of M. de Bruyn. Working with a solution of free hydroxylamine, distilled according to De Bruyn's method, interaction with methyl iodide occurs immediately with evolution of heat. After the action is over, a white crystalline salt separates from the mixture, and a further quantity may be obtained by adding ether to the solution. This substance consists almost entirely of a *trimethyl hydroxylamine hydriodide.* The authors have not succeeded in obtaining any considerable quantity of the monomethyl derivative described by De Bruyn. The salt of the trimethyl base is easily purified by crystallising it from a mixture of methyl alcohol and ether. It melts with decomposition near 127°. The *hydrochloride* (m. p. 200°) and the *sulphate* are stable crystalline salts, which may be crystallised from water without decomposition. By the action of baryta water on the sulphate, or of silver oxide on the hydriodide, the free trimethyl hydroxylamine was obtained. It crystallises readily and is remarkable for its stability; the aqueous solution does not reduce Fehling's solution, and may be boiled without undergoing any appreciable change. The properties and reactions of this interesting compound are being fully investigated.

The authors' experience is that the action of alkyl iodides on hydroxylamine does not constitute a satisfactory process of preparing β-mono-alkyl derivatives of hydroxylamine. They hope shortly to be able to give a more detailed account of their work, which is still in progress.

2 7. The reduction products of nitro-compounds." By Wyndham R. Dunstan, F.R.S., and T. S. Dymond.

The authors have conducted a number of experiments on the reduction of aliphatic nitro-compounds with various weak reducing agents. They have obtained evidence of the formation under certain conditions of the corresponding *aldoximes* or *ketoximes*, nitroethane furnishing acetaldoxime, nitropropane propionaldoxime, secondary nitropropane, acetoxime, &c. In addition, substituted hydroxylamines are produced, as first observed by Victor Meyer and recently by Bamberger, as well as the corresponding amines. The aldoxime or ketoxime would appear to be an early, if, indeed, not the first, product of the reduction of the nitro-paraffins.

During the past year the authors have been unavoidably prevented from continuing this enquiry, but one of them has now resumed it. It is hoped that a method of reduction may be found which will give a large yield of the oxime; hitherto the amount produced has been very small, and therefore the oxime is difficult to isolate and characterise. An attempt is being made to ascertain whether the formation of the aldoximes or ketoximes is to be regarded as an intermediate stage in the reduction of the nitro-compound to the substituted hydroxylamine as represented by the diagram



$$CH_3\underset{\underset{O}{\diagdown\diagup}}{CHN}{\cdot}OH \rightarrow CH_3CH{:}NOH \rightarrow CH_3CH_2NHOH$$

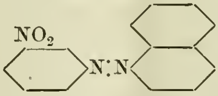
Nitroethane (tautomeric formula). Acetaldoxime. Ethyl hydroxylamine.

With this view, the reduction products of aldoximes and ketoximes are also being examined.

28. "Notes on meta-azo-compounds." By R. Meldola, F.R.S., and Edgar S. Hanes.

The peculiar interest attaching to azo-compounds which do not admit of being formulated on Fittig's "quinonoïd" type has been referred to by one of the authors and F. B. Burls (Proc., 1893, 126). Since the publication of the note in question, numerous experiments have been made with a view to the discovery of some convenient source of such compounds, and more especially metamidoazobenzene, a comparison of which with the ordinary para-compound ("aniline yellow") cannot fail to give important results. The practical difficulties of the work have, however, proved to be so much greater than was anticipated at the outset, that we have thought it desirable to place our present results upon record, as much more time will have to be devoted to the subject before materials for a complete discussion of the problem of the constitution of the azo-compounds can be obtained.

In the experiments described last year, metaphenolazo-α-naphthylamine was prepared by combining diazotised metamidophenol with α-naphthylamine. It was not found possible to replace the amido-group by hydrogen in this compound by the Griess method (*loc. cit.*, p. 129). Another attempt was therefore made, starting from metanitrobenzeneazo-α-naphthylamine (Trans., 1884, 114); but although we have succeeded in obtaining a little of the compound sought for, viz., metanitrobenzeneazo-α-naphthalene, the yield is so small that the experiments in this direction have not been further pursued. The difficulty in this case arises partly from the extreme insolubility of the nitroazo-base, and its sulphate and hydrochloride, in absolute alcohol, and partly from the formation of resinous products. It was found necessary, in the first place, to dissolve the nitroazo-base in a sufficient quantity of glacial acetic acid to keep it in solution in the cold, then this solution was added to a large volume of absolute alcohol, and the calculated quantity of sodium nitrite dissolved in the smallest possible quantity of cold water immediately poured in, and a few drops of strong sulphuric acid finally added. The solution was allowed to stand for some hours in the cold, the reaction going on slowly all the time, with the evolution of nitrogen and the deposition of a brown, resinous substance. The decomposition is completed by boiling as long as nitrogen is evolved, the cold solution filtered to remove the resinous impurity, and the alcohol partly evaporated off. On diluting the final alcoholic liquor with water, the nitroazo-compound separates out after some hours in the form of fine, red needles. The substance was purified by crystallisation from dilute alcohol with animal charcoal, and finally from benzene. It was thus obtained in the form of stumpy prisms of a deep, red colour, melting at 127—128°. Analysis showed that the NH_2 group had been replaced by hydrogen, and the formula of the compound is, therefore,



Calculated for above formula, 15·16 per cent. N. Found, 15·03 per cent. Metanitrobenzeneazo-α-naphthalene is readily soluble in alcohol and benzene, its solutions being orange.

It dissolves in strong sulphuric acid with a violet colour, becoming redder on dilution with water.

Several attempts to replace the amido-group by hydrogen in metanitrobenzeneazo-β-naphthylamine (Trans., 1884, 116) resulted in the formation of metanitrobenzeneazo-β-naphthol (Trans., 1885, 668).

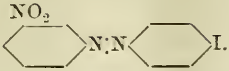
Experiments were in the next place undertaken with a view to ascertain whether a more satisfactory yield could be obtained from a simpler nitroamidoazo-compound, viz., metanitroamidoazobenzene (Trans., 1884, 112). As this compound, which was described by one of us 10 years ago, was not isolated in a state of purity at the time of its discovery, a further study of its mode of formation and properties was undertaken. Our experiments prove that the most advantageous method of preparing this compound is to combine diazotised metanitraniline with aniline in the presence of sodium acetate so as to form in the first place the mixed diazoamide, $(m)NO_2 \cdot C_6H_4 \cdot N_3H \cdot C_6H_5$, in the usual way. This compound is collected, washed well with water, and then transferred to a flask or beaker and allowed to stand for two or three days suspended in dilute hydrochloric acid. The strength of the acid may be increased from day to day, and finally the contents of the vessel must be kept at 80—90° in a water bath till no more nitrogen is evolved. The transformation of the diazoamide takes place very well by this method, and by this method only. The usual process of transforming, viz., warming with aniline and aniline hydrochloride, gives a mixture of metanitraniline and amidoazobenzene,

$$NO_2 \cdot C_6H_4 \cdot N_3H \cdot C_6H_5 + C_6H_5 \cdot NH_2 = NO_2 \cdot C_6H_4 \cdot NH_2 + C_6H_5 \cdot N_3H \cdot C_6H_5.$$

The yield of crude nitroamidoazobenzene obtained by the hydrochloric acid method is not very great, averaging in various preparations about 30 per cent. of the metanitraniline employed. A large quantity of metanitraniline is found in the acid filtrate, and can be recovered by precipitation with alkali, and purified by crystallisation from hot water.

In order to purify the nitroamidoazobenzene, the crude product is dissolved in hot alcohol with the addition of strong hydrochloric acid, filtered when cold to remove tarry impurity, and the solution made alkaline with ammonia, and diluted with water. The base separates out as an orange crystalline powder, and the process of purification must, if necessary, be repeated. The substance is finally crystallised from dilute alcohol or toluene. To the properties of the compound as described in 1884 we have but little to add. When pure it melts without decomposition at 212—213°. The nitro-group practically destroys the basic character of the compound, which is quite insoluble in dilute aqueous acids, and dissolves only with difficulty in alcohol and hydrochloric acid. In order to further characterise it, the acetyl derivative was prepared by boiling the substance for a short time with glacial acetic acid and acetic anhydride. The product after crystallisation from alcohol formed orange scales melting at 166—167°. Calculated for $NO_2 \cdot C_6H_4 \cdot N_2 \cdot C_6H_4 \cdot NH \cdot C_2H_3O$, 19·71 per cent. N. Found, 19·91 per cent. N.

Metanitroparaiodoazobenzene was also prepared by diazotising the base dissolved in strong sulphuric acid, diluted with about an equal volume of water, and mixing with a solution of potassium iodide. After crystallisation from alcohol, the compound consists of ochreous needles, melting at 123—124°. Calculated, 11·89 per cent. N ; 35·97 per cent. I. Found, 12·11 per cent. N; 36·15 per cent. I. The constitution is doubtless



An azimide was prepared by diazotising the compound in sulphuric acid solution with sodium nitrite, adding bromine and decomposing the diazoperbromide with ammonia in the usual way. The perbromide separates as a red oil, which solidifies to a crystalline cake on standing. The azimide, after repeated crystallisation from dilute alcohol with animal charcoal, consists of white needles, melting at 80°.

Calculated for $(m)NO_2\cdot C_6H_4\cdot N_2C_6H_4\cdot N_3(p)$, 31·34 per cent. N.
Found, 31·11 per cent.

By diazotising the nitroamidoazo-compound in the presence of sulphuric acid, and boiling the diazosulphate with water, a phenolic product was obtained, having all the properties of metanitrobenzeneazophenol.

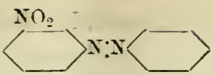
We did not have enough of the substance to obtain a pure specimen for analysis, but some of the compound obtained by combining diazotised metanitraniline with phenol in alkaline solution was prepared for comparison, and we are satisfied as to their identity. The product obtained by pouring a solution of metanitrodiazobenzene chloride into an alkaline solution of phenol always contains a small quantity of a bye-product insoluble in cold dilute caustic soda, and consisting, probably, of the disazo compound, $[(m)NO_2\cdot C_6H_4\cdot N_2]_2\cdot C_6H_3\cdot OH$.

Metanitrobenzeneazophenol, when purified by crystallisation from toluene, forms deep orange-red nodular crystals, melting at 159°. Noelting, who first prepared this compound, gives the melting point as 146—147° (*Ber.*, 1887, 2998), a discrepancy for which we are unable to account. Analysis proved our preparation to be quite pure. Calculated, 17·28 per cent. nitrogen; found, 17·31 per cent.

The NH_2-group was eliminated from the nitroamidoazobenzene in the following manner:—4 grams were dissolved in 200 c.c. absolute alcohol, a few drops of strong sulphuric acid added to the cold solution, and the calculated quantity of sodium nitrite, dissolved in a little water, poured in.

The mixture is then boiled for an hour, the alcohol evaporated off, and the product thrown out by adding water.

The yield is by no means good, as much resin is formed. The pure compound, obtained by repeated crystallisation from absolute alcohol, consists of dull orange-red needles, melting at 82—83°. It is the metanitroazobenzene sought for,

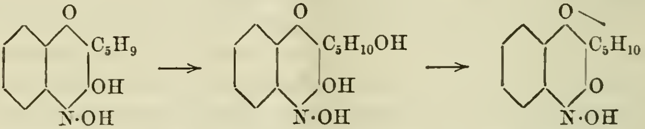


Calculated, 18·50 per cent. nitrogen; found, 18·38 and 18·39 per cent.

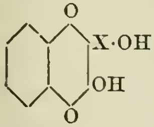
The nitro-group could not be reduced without simultaneous separation of the azo-group, so that the desired metamidoazobenzene could not be prepared from this compound.

29. "Conversion of ortho- into para-, and of para- into ortho-quinone derivatives. III. The hydroximes of the lapachol group." By Samuel C. Hooker and Elwood Wilson.

The authors have found that by the action of mineral acids upon the hydroximes of lapachol and hydroxyhydrolapachol the same compound is formed in both cases, and that this is identical with the hydroxime obtained by Paterno and Minnuric (*Gazzetta*, **19**, 613) by treating β-lapachone with hydroxylamine hydrochloride. From these facts they deduce the following formulæ for the compounds studied.



Lapachol hydroxime. Hydroxyhydrolapachol hydroxime. β-Lapachone hydroxime.

Evidence is thus furnished that the substitution of the diad group $=N{\cdot}OH$ for the quinonic oxygen, does not modify the tendency which, as has been previously shown by one of the authors, frequently exists for compounds of the type  , to form anhydrides derived from β-naphthaquinnone.

The hydroxime of α-lapachone is also described, and it is shown that it can be converted by concentrated sulphuric acid into β-lapachone-hydroxime, a change involving the conversion of the para- into the ortho-quinone group.

30. "The behaviour of alloys in a voltaic circuit." By A. P. Laurie.

In former papers on this subject I have shown that there is reason to believe, owing to the remarkable discontinuity in the curve of electromotive force, that a compound exists in the series of copper-tin, copper-zinc, and gold-tin alloys, and I have also shown that in the alloy between tin, lead, zinc, and cadmium a very small quantity of the more positive metal in the alloy produces its full E.M.F., thus apparently indicating that the metals are merely mixed together. I am at present engaged in applying the method to all the alloys described in Matthiessen's paper on "Electric Conductivity (*Phil. Mag.*, **150**, 1860, 161), but in the meantime there are certain isolated points which seem worthy of being put on record. In the first place I have found indications of a third group of alloys which neither give at once the E.M.F. of the more positive metal, nor show any abrupt discontinuity in the curve of E.M.F. on passing over a particular alloy. In these alloys the E.M.F. rises rapidly, and a continuous curve to the value of the more positive metal as we pass through alloys containing more and more of the more positive metal in the mixture. This curve so closely resembles the curve obtained on increasing the amount of free iodine present in solution in an iodine cell, as to suggest at once that these metals correspond in their behaviour to each other, to the solution of one substance in another rather than the formation of a compound having a definite formula. If for instance we take antimony and lead, and measure the E.M.F. of antimony against lead, we shall find that lead is the more positive metal, and testing antimony against alloys of antimony containing increasing quantities of lead, the E.M.F. gradually rises in a continuous curve.

The readings were taken with both the alloy and the antimony in a cell of sodium chloride.

Alloy.						E.M.F.	
Antimony	containing	4·76	per cent.	lead—	antimony	0·123	volt.
„	„	9·05	„	„	„	0·169	„
„	„	13·4	„	„	„	0·182	„
„	„	16·8	„	„	„	0·215	„
		Antimony—lead............				0·246	„

These readings were taken with a fresh set of alloys (at a future date to the last), also in a single cell of sodium chloride.

Alloy.						E.M.F.	
Antimony	containing	4·74	per cent.	lead—	antimony	0·057	volt.
„	„	9·209	„	„	„	0·112	„
„	„	13·03	„	„	„	0·134	„
„	„	17·03	„	„	„	0·155	„
		Antimony against lead				0·207	„

Another set of readings taken with the same set of alloys as in Table II, only with the antimony in an inner cell containing antimony chloride, and the alloy in an outer cell containing sodium chloride, gave the following results :—

Alloy.	E.M.F.
Antimony—antimony	0·285 volt.
Antimony containing 4·74 per cent. lead—antimony	0·358 ,,
,, ,, 9·209 ,, ,, ,,	0·415 ,,
,, ,, 13·03 ,, ,, ,,	0·434 ,,
,, ,, 17·03 ,, ,, ,,	0·475 ,,
Antimony—lead	0·494 ,,

Another set of readings taken with the same alloys under the same conditions as before, except that the alloys were in an outer cell of potassium nitrate, gave the following results :—

Alloy.	E.M.F.
Antimony—antimony	0·259 volt.
Antimony containing 4·74 per cent. lead—antimony	0·342 ,,
,, ,, 9·209 ,, ,, ,,	0·386 ,,
,, ,, 13·03 ,, ,, ,,	0·413 ,,
,, ,, 17·03 ,, ,, ,,	0·415 ,,
Lead—antimony	0·456 ,,

The same set of alloys read again with the alloy in an outer cell of magnesium sulphate.

Alloy.	E.M.F.
Antimony—antimony	0·254 volt.
Antimony containing 4·74 per cent. lead—antimony	0·2903 ,,
,, ,, 9·209 ,, ,, ,,	0·342 ,,
,, ,, 13·031 ,, ,, ,,	0·386 ,,
,, ,, 17·03 ,, ,, ,,	0·435 ,,
Antimony—lead	0·451 ,,

It will be noticed that in each of these tables the E.M.F. rises rapidly in a continuous curve. Other examples of alloys which behave in this way will be given in a paper on Matthiessen's work. It may be of interest to note here in passing that alloys of this type seem to be apt to yield very inconsistent readings. This can be very easily understood. When the metals are merely mixed together, some portion of the free metal may be expected to be present on the surface of the alloy and produce its effect on the electrometer; or when an actual chemical combination has taken place, we may expect to find that all the metal has combined which can combine, and consequently a want of equal mixture between the compound, and the metal which is present in excess will not affect the electrometer, but where the bond is so loose, as in cases of solution where, at the same time, a certain loss of energy has taken place during that solution, we might expect to find different parts of the same alloy, or the same alloy made up on different occasions, giving inconsistent results. Another interesting subject is the result of amalgamating alloys with mercury. In the case of the copper-tin and copper-zinc alloys, I found that amalgamation with mercury did not appreciably affect the electrometer readings, the discontinuity on passing the compound appearing as before. This seemed to indicate that the compound formed between the two metals was sufficiently stable to dissolve in mercury without being decomposed, but in the case of the gold-tin alloys the case is different. In the accompanying table I give the readings in the first column of the E.M.F. of gold-tin alloys against gold in a solution of common salt; while the absolute readings are different, the form of the curve is practically the same as that published by me in the *Philosophical Magazine*, from readings obtained in a stannous chloride gold chloride cell. The second column contains the readings after amalgamation with mercury. It will be noted that these form a gradually ascending line, and that all trace of the compound has disappeared. I can only suppose that the mercury present decomposes the compound. This behaviour of gold-tin and mercury so closely resembles the replacement of one element by another in a compound, that it led me to look further for indications of such changes, and for this purpose I selected the three metals copper, tin, zinc, as explained in my former papers; the indications of the electrometer readings seemed to show the existence of a compound between copper and tin having the formula of Cu_3Sn, and a compound between copper and zinc having a formula of $CuZn_2$. First of all, therefore, an alloy was made containing 35 per cent. of tin, which was just a little less than that necessary to form a compound. The E.M.F. between copper and tin, copper and zinc, copper and the copper-tin compound was then taken in a solution of common salt. Having done this, the copper-tin compound was fused with a weight of zinc equal to the copper contained, the assumption being that if the zinc did not combine with the copper, the E.M.F. of the three metals fused together would be the same as that of the zinc against copper, which is much the highest E.M.F. of the three; while if, on the other hand, the zinc combined with the copper and threw out the tin, the fused metals might be expected to give the E.M.F. of tin. The following table shows the results of the measurements.

Alloy.	E.M.F.
Copper against tin	0·272 volt.
,, ,, zinc	0·84 ,,
,, containing 50 per cent. Zn—copper	0·097 ,,
(Alloy of) zinc 50 per cent., tin 35 per cent., copper —copper	0·25 ,,

It will be noticed that the E.M.F. of the three metals fused together is almost exactly the same as that obtained from tin, showing apparently that zinc replaces tin in its compound with copper. There is another subject to which I have directed some attention with only negative results. It is a remarkable fact, of which sufficient notice does not seem to have been taken, that so few metals seem to combine with each other; even those which lie close together in the periodic table, enter into combination, while metals which lie far apart on the table refuse to combine. One possible explanation of this which occurred to me was that the temperature at which the metals fused, the compounds formed dissociated, and if the temperature could be lowered sufficiently while keeping them fluid they might be persuaded to combine. I, therefore, attempted to get zinc and lead to combine by lowering the melting point by the introduction of bismuth and of bismuth mercury, and allowing the alloys to cool slowly in a bath of oil; in every case, however, the E.M.F. of zinc was obtained from the mixture of metals, so that the explanation does not seem to lie in this direction. It is a subject well worthy of enquiry and experiment, as we are unaware at present how many elements there are which do not combine with one another, and we have no indication of the properties of the elements by which this absence of combination is constituted.

ADDITIONS TO THE LIBRARY.

I. *Donations.*

The Metallurgy of Gold. By T. K. Rose. Edited by W. C. Roberts-Austen. London 1894. From the Author.

Ueber Einige Fundamental-Satze der Chemie, insbesondere das Dalton-Avogadro'sche Gesetz. Von H. Debus. Cassel 1894.
From the Author.

Cape of Good Hope: Department of Lands, Mines, and Agriculture. Report for 1893 of the Senior Analyst on the Analytical Laboratory and Agricultural and Mineralogical Museum. Cape Town 1894.
From the Senior Analyst.

II. *By Purchase.*

Traité d'Analyse chimiques, micrographique et microbiologique des Eaux Potables. Par A. J. Zune. Paris et Bruxelles 1894.

Handbuch der Metallhüttenkunde. Von C. Schnabel. Ester Band: Kupfer, Blei, Silber, Gold. Berlin 1894.

At the next meeting of the Society, on Thursday, June 21st, the following papers will be read:—

"The specific character of the fermentative functions of yeast cells." By Adrian J. Brown.

"The interaction of lead sulphide with lead sulphate and oxide." By J. B. Hannay.

"The oxidation of tartaric acid in the presence of iron." By H. J. H. Fenton.

"A specimen of early Scottish iron." By Mrs. Dougal.

"The mineral waters of Cheltenham." By Professor Thorpe, F.R.S.

"The relation between the solubility of a gas and the viscosity of its solvent." By Professor Thorpe, F.R.S., and Mr. J. W. Rodger.

"The physical properties of solutions of arsenious sulphide." By S. E. Linder and H. Picton.

"The electrical repulsion of certain solutions." By H. Picton and S. E. Linder.

EXTRA MEETING.

An Extra Meeting of the Society will be held at the Royal Institution, Albemarle Street, on Thursday, June 28th, at 9 P.M., when Professor Dewar, F.R.S., will describe and illustrate his recent observations on phosphorescence and photographic action at very low temperatures.

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PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

No. 141. Session 1893-94.

June 21st, 1894. Dr. Armstrong, President, in the Chair.

Mr. E. F. Harrison was formally admitted a Fellow of the Society.

Certificates were read for the first time in favour of Messrs. Alexander Cameron, 13, Stonenest Street, Tollington Park, N; Charles A. Fogg, 48, Kent Street, Bolton.

Of the following papers those marked * were read:—

*31. "A specimen of early Scottish iron." By Margaret D. Dougal.

The specimen was found on the site of the Fasagh bloomeries, on the north-east shore of Loch Maree, Ross-shire—the neighbourhood where the manufacture of iron in Scotland appears to have had its rise nearly three centuries ago. Full particulars of the mechanical characters, determined by Professor Unwin in the engineering laboratory of the Central Institution, are given in the paper, as well as the details of the chemical analysis. Its chemical composition was C = 0·192; Si = 0·077; S = 0·012; P = 0·087; Mn = 0·038; Ti = 0·002; Te = 99·770; Total = 100·178. From a report by Mr. Ames, the art-metal worker, the metal was of excellent quality, resembling the famous Swedish iron used by the English smiths of the 17th and 18th centuries.

*32. "The interaction of sulphide with sulphate and oxide of Lead." By J. B. Hannay.

In this paper the author examines the equations suggested by Percy to account for the smelting of lead in the reverberatory furnace. The two main reactions which are supposed to occur are usually represented by the equations $PbS + PbSO_4 = 2Pb + 2SO_2$, and $PbS + 2PbO = 3Pb + SO_2$; and although Percy relies on the first as representing what takes place, he also says that a mixture of the sulphate and oxide reduces the sulphide. The author finds that a much more complex reaction takes place, since metallic lead, when formed, attacks the remaining sulphate, producing litharge, which in its turn reacts with the sulphide, while some of the sulphide is removed by being dissolved in the metallic lead, and some is volatilised as the volatile compound PbS_2O_2. The result varies according to temperature and the method of mixing the substances. The following equations correspond with the results the author has obtained :—

(1.) Lead sulphide and sulphate mixed in molecular proportions and very finely ground, and brought to calm fusion :—

$$12PbS + 12PbSO_4 = \underbrace{11Pb + 2PbS}_{\text{Hard lead.}} + \underbrace{6PbO + 2PbS + 2PbSO_4}_{\text{Slag.}}$$

$$+ \underbrace{PbS_2O_2 + 16SO_2}_{\text{Fume.}}$$

34·8 per cent. of lead was obtained instead of 76·3 as required by Percy's equation. When the sulphide of lead is in small pieces, the reaction yields more lead, but otherwise pursues a similar course :—

$$(2.)\ 12PbS + 12PbSO_4 = \underbrace{14Pb + 2PbS}_{} + \underbrace{4PbO + 2PbSO_4 + PbS}_{}$$

$$+ \underbrace{PbS_2O_2 + 17SO_2}_{}.$$

With excess of sulphate the result is :—

$$(3.)\ 15PbS + 12PbSO_4 = \underbrace{15Pb + 3PbS}_{} + \underbrace{4PbO + 2(PbS \cdot PbO)}_{}$$

$$+ \underbrace{PbS_2O_2 + 20SO_2}_{}.$$

On fusing lead sulphide and adding solid sulphate, the result is :—

$$(4.)\ 3PbS + 3PbSO_4 = 3Pb + 2PbO + \underbrace{PbS_2O_2 + 4SO_2}_{}.$$

On fusing the sulphate and adding solid sulphide, the result is :—

$$(5.)\ 15PbSO_4 + 5PbS = 12PbO + 4PbSO_4 + \underbrace{4PbS_2O_2 + 8SO_2}_{}.$$

The temperature in this last case was much higher owing to the high melting point of the lead sulphate, and thus a larger amount of fume was produced.

On mixing sulphate and oxide in the proportions which ought to form lead and sulphur dioxide, as by the equation:—

$$12PbS + 6PbSO_4 + 12PbO = 30Pb + 18SO_2,$$

no such result was obtained, but the reduction took this form:—

$$\begin{aligned} 12PbS + 6PbSO_4 + 12PbO = {} & \underbrace{16Pb + PbS}_{} + \\ & \underbrace{4PbO + 4(PbS{\cdot}PbO) + PbSO_4}_{} + 12SO_2. \end{aligned}$$

The author has shown in another paper, that the sulphide and oxide do not react to form lead, but combine together to form the substance PbS·PbO, which is the basis of lead slags.

DISCUSSION.

Professor ROBERTS-AUSTEN said that it would be within the recollection of the Fellows of the Society, that when Mr. Hannay's paper was read, on the 17th of May last, he pointed out that Mr. Hannay would be doing good service if he really added to our knowledge of the condensible products formed during lead smelting. Professor Austen, however, considered that the author's views had been stated in such a way as to fully justify chemists in asking for further evidence. The next morning Professor Austen had begun certain experiments on the lines indicated by Mr. Hannay. The President, also, appeared to have attacked the question, with the advantage of the co-operation of Mr. Hannay. Mr. Hannay's statements presented themselves under two main aspects. It might be well either (1) to test the accuracy of his views as to the action of atmospheric air on sulphide of lead, or (2) to endeavour to obtain evidence as to the existence of volatile gaseous compounds of sulphide of lead. The speaker had adopted the latter course. He stated that he had understood Mr. Hannay to say distinctly, that if a mixture of sulphide and sulphate of lead were heated strongly no reaction ensued; hence Professor Austen's appeal in favour of the accuracy of certain of the equations which were given by Percy and accepted by metallurgists. He was glad, however, to find that Mr. Hannay did not maintain this extreme view. Professor Austen had experimentally confirmed the fact that the following equation is substantially correct:— $PbS + 3PbSO_4 = 4PbO + 4SO_2$. This is a very important point, as it is one of Percy's main equations; but he had pointed out on the previous occasion, that both this equation and the one which has hitherto represented the reaction between oxide and sulphide of lead are strongly endothermic, and in the case of an endothermic equation some explanation had to be sought;

energy in some form had to be imported into the system, and an endothermic equation would represent a reaction which would be less likely to take place at a low than at a high temperature. In the case of the well known endothermic interaction between carbon and the oxides of iron, it was probable that the iron carbonyl played an important part, which certainly pointed to the possibility of similar action on the part of *gaseous metallic* compounds in the metallurgy of lead. It had, therefore, appeared to him that the conditions should be carefully studied; and he proceeded to state the results of the experiments he had instituted. First as regards the volatility of lead sulphide in various gases. The well known statement, "that the volatilisation of sulphide of lead is promoted by currents of gas, such as proceed from the combustion of fuel," a statement made by Dr. Percy in 1870, might well be taken as a starting point. There could be no doubt that when galena is strongly heated in a porcelain tube between two plugs of asbestos in a current of sulphur dioxide, the galena is volatilised, and is driven right through the plugs, condensing on the other side of them. Such experiments were made in the School of Mines laboratory, the temperature being carefully measured by the aid of a thermocouple, and it was found that at a temperature of 1357° C., 9 grams of galena lost 38·2 per cent. of its weight in sulphur dioxide in 20′; while 9 grams of galena lost 37·7 per cent. in nitrogen in 20′. At a still higher temperature, 1434° C., 9 grams of galena lost 50·2 per cent. of its weight in sulphur dioxide in 20′; while 9 grams of galena lost 72·3 per cent. of its weight in nitrogen in 20′. This result showing the volatility of galena in ordinarily pure nitrogen was not a little surprising; but Mr. Rose had made a perfectly independent experiment, the result of which quite confirmed the volatility of galena in nitrogen. Professor Austen had also ascertained the fact that at 1200° galena may be rapidly distilled *in vacuo*, and, so far, he had been unable to obtain any evidence in favour of the view that sulphur dioxide promotes the volatilisation of lead sulphide more than nitrogen does. He had, however, tried a further experiment. A kind of air thermometer was arranged, with a porcelain tube for a bulb, in which a certain amount of galena was placed in an atmosphere of sulphur dioxide. The tube was then heated strongly, and the expansion of the gas carefully measured by means of a moving index of mercury in a horizontal capillary tube. The presence of galena produced no abnormal change in the volume of sulphur dioxide such as might be expected to occur if a gaseous compound of sulphur dioxide and galena were formed. It should be remarked, however, that sulphur dioxide alone appears to exhibit contraction about 1000°, and the cause of this fact is being examined; but the presence of galena did not increase the observed condensation. Metallurgists would welcome the proof of the existence of gaseous compounds of lead sulphide; but although Mr. Hannay had undoubtedly shown that the whole metallurgy of lead should be further investigated, the existence, composition, and nature of the volatile compounds could not, as yet, be considered to be established.

Mr. Rose exhibited a porcelain tube in which 6 grams of galena, contained in a boat between asbestos plugs, had been heated at 1300° for half an hour in a slow current of nitrogen, the temperature being taken by Le Chatelier's optical pyrometer. Practically the whole of the galena had been volatilised, and, passing through the plugs in both directions, had been condensed as crystals in the cold parts of the tube. He had tried to isolate the supposed compound, PbS_2O_2, by means of Deville's hot and cold tubes, galena being heated to about 1250° in a stream of sulphur dioxide, but had been unsuccessful, the sublimate on the cold tube consisting entirely of lead sulphide. It was to be remembered that several substances, such as ozone and oxide of silver, which, although more or less unstable at moderate temperatures, could exist at a white heat, had been prepared in this way, and the method had appeared to be the most likely one to succeed in effecting the isolation of PbS_2O_2. The failure was therefore not without significance.

Mr. H. C. Jenkins said that some experiments had been carried out in the metallurgical laboratories of the Royal College of Science. It was found that lead sulphide (galena) was easily volatile in a vacuum at a temperature only a few degrees above its melting point. In a current of sulphur dioxide the rate of volatilisation was, as would be expected, much increased, but a similar current of nitrogen gave even better results than sulphur dioxide. Very careful experiments were made with mixtures of galena and sulphate of lead, but, although some of the products resembled those that Mr. Hannay had described, yet the evidence obtained did not point to the existence of a volatile compound PbS,SO_2. In some cases only the acting compounds were present; in others the experiments were performed in an atmosphere of sulphur dioxide in the presence of furnace gas. Metallic lead was only seen as a separate product in the latter case. But it was found that pure metallic lead is capable of decomposing sulphur dioxide, forming sulphur and oxide. Experiments were still in progress with a view to obtain quantitative knowledge of the change. The existence of volatile lead compounds would, if proved, offer an easy explanation of the cause of lead fume, but in view of the volatile character of well known compounds of lead at furnace temperatures, much more experimental evidence than has yet been afforded is needed to demonstrate the formation of new compounds.

The President said, that the discussions to which Mr. Hannay's papers had given rise were of considerable value in calling attention to the many interesting points in the metallurgy of lead which still required investigation. The main question around which the interest of the discussion centred was that relating to the existence of volatile compounds of lead sulphide. The experiments which he had witnessed certainly favoured the conclusion that sulphur dioxide exercised a specific effect in volatilising lead sulphide; but assuming that the evidence that combination took place was satisfactory, he could not regard Mr. Hannay's observations on the extent to which volatilisation took place as satisfactory determinations of the composition of the volatile compound; such a compound would probably be dissociable, and, if so, it was not to be expected that the gas and galena would pass over and be collected in exact molecular ratios. The strongest evidence was undoubtedly that derived from passing air into molten galena; the manner in which galena volatilised and passed away as lead sulphate under such conditions was extraordinary, and still more remarkable was the fact that, as Mr. Hannay stated, just half the lead was obtained in the metallic state. Experiments made in his laboratory, under Mr. Hannay's direction, had given this result, and it was certainly a remarkable coincidence if the result were but accidental. It appeared to him that, although Mr. Hannay could not be held to have established his point, he had called attention to peculiarities in the behaviour of lead sulphide which were of great interest to metallurgists, and that he had clearly made out a case for enquiry.

Mr. Hannay, in reply, said that he was glad to find it was now recognised that the simple equations of the text-books did not adequately represent the facts, and that nearly all the furnace reactions of lead compounds were very complex. As to the volatility of the sulphide and the formation of a definite compound with sulphur dioxide, this conclusion was based on the action of air on molten galena, an action which always proceeded in the same manner, and was represented by the equation $2PbS + O_2 = Pb + PbS{\cdot}SO_4$, as exactly one-half of the galena is reduced to lead and left in the metallic state, and one-half is volatilised with the sulphur dioxide. Whether this was a definite compound or a mere chance volatility in molecular proportions was a question which might still admit of experimental investigation, and it was to be hoped that some of those who had spoken would carry the work further. As showing that sulphur dioxide when set free in intimate contact with molten galena, does act in a special manner, it might be stated that while nitrogen and hydrogen gases passed at the rate of 1 litre in three minutes through the molten sulphide, carried over the galena as vapour at the rate of 3·5 grams per litre of gas passed, air under the same conditions carried over 5·2 grams per litre. Now if the amount carried over by the nitrogen of the air were the same as that carried over by pure nitrogen, there is a large excess carried over by the sulphur dioxide (formed by the combination of the oxygen of the air with the sulphur of the galena), and this excess is present in nearly the proportion indicated by the formula $PbS{\cdot}SO_2$ or PbS_2O_2. All the evidence pointed to the fact that when sulphur dioxide was formed in intimate contact with molten galena, every molecule of sulphur dioxide rendered volatile 1 molecule of galena, and subsequently deposited it on cooling. The volatility is so profoundly modified by temperature, that experiments are not comparable unless carried out at the same temperature, a result difficult to obtain, but Mr. Hannay hoped that Professor Roberts-Austen would test the matter, and lay down accurate data for future work, as all statements of temperature had hitherto been only the roughest approximations.

*33. "The mineral waters of Cheltenham." By T. E. Thorpe, D.Sc., F.R.S.

This communication contains the results of the analysis of the waters of the following wells:—(A.) (1) Well Place; (2) Christchurch Road. (B.) (1) Lansdowne Well; (2, 3, and 4) Pitville Spas. The determinations, so far as applicable, are compared with the results of analyses by Abel and Rowney, made in 1847, from which it appears that the waters have experienced no sensible alteration in composition during the last half century.

*34. "The oxidation of tartaric acid in presence of iron." By H. J. H. Fenton, M.A.

This paper gives an account of the investigation undertaken by the author to explain the cause of a peculiar colour reaction of tartaric acid observed by him some years ago. Free tartaric acid, or a soluble tartrate, is oxidised by certain agents in presence of a trace of ferrous salt, when, on addition of alkali, a beautiful violet colour is produced.

The isolation of the substance which gives rise to this colour was, in the first instance, a matter of considerable difficulty, owing to the unstable nature of the solution, but a method has now been devised whereby it can be obtained in considerable quantities and in a state of purity. It has the appearance of a shining, white, crystalline mass with a pearly lustre. The crystals are quite permanent in the air, but effloresce over sulphuric acid or when heated. Analyses and molecular weight determinations by different methods show that the substance is a dibasic acid of the formula $C_4H_4O_6$, which crystallises with $2H_2O$. It is very sparingly soluble in cold water, acts as a powerful reducing agent, and gives a violet colour with ferric chloride in presence of alkali, changed to a transient green by acids. On heating with hydrogen iodide, it gives succinic acid, glycotartaric acid being an intermediate product. The aqueous solution decomposes slowly at ordinary temperatures, and rapidly on heating, giving carbon dioxide and an aldehydic substance which is under examination. Phenyl hydrazine gives two crystalline compounds, one a brilliant silver-white, and the other golden-yellow.

The methyl salt is volatile at about 150°, and may be sublimed in crystals; the ammonium, sodium, and barium salts also are easily obtained in the crystalline form. The acid somewhat resembles dioxytartaric acid in the sparing solubility of its sodium salt, but differs considerably from that acid in other respects.

The constitution of the acid will be considered in a future communication, but the author intends also to investigate several side issues suggested by this work, such as the detection of peroxide of hydrogen under certain conditions, the preparation of glyoxylic acid, and the oxidation of other substances in presence of ferrous salts.

*35. "The supposed relation between the solubility of a gas and the viscosity of its solvent." By T. E. Thorpe, F.R.S., and T. W. Rodger.

In the *Zeit. für physik. Chem.*, 9, 171, 1892, appeared a short communication by L. W. Winkler, in which he attempted to account for the fact that the solubility of a gas in water diminished with rise in temperature. The conclusions which he arrived at may thus be stated:—

(1.) For the same gas the percentage diminution in its absorption coefficient for any temperature-interval is proportional to the corresponding percentage diminution in the viscosity of the solvent.

(2.) For any gas the percentage diminution in its absorption coefficient for the same temperature-interval is proportional to the cube root of its molecular weight.

These conclusions were based on Winkler's own observations on the absorption coefficients of hydrogen, oxygen, nitrogen, nitric oxide, and carbonic oxide in water, and on the relative numbers given by Graetz for the viscosity coefficients. The authors, when endeavouring to ascertain how far these deductions were affected on employing the values recently obtained by them for the viscosity coefficients of water, have found that, owing to imperfect mathematical treatment, Winkler's conclusions have to be modified. The deductions which the facts appear to warrant are :—

(1.) For the same gas the diminution in solubility, and not the percentage diminution, is proportional to the corresponding diminution in viscosity.

(2.) For any gas, the factor of proportionality is greater the greater its molecular weight, although the two do not appear to be simply related to one another.

The authors also call attention to the fact that since the viscosities of a large number of organic liquids at different temperatures have now been determined, lack of data concerning the solubility of gases in such solvents alone stands in the way of a more complete investigation of the interdependence of solubility and viscosity.

*36. "The specific character of the fermentative functions of yeast cells." By Adrian J. Brown

The usually accepted view as to the cause of the exhibition of the fermentation functions of yeast cells is, that it is a starvation phenomenon brought about by want of free oxygen during the life of the cells in a fermentable liquid; or, more briefly, that it is a phenomenon of "life without air." This view was originated by Pasteur, a full account of the experimental results which led him to formulate this theory being given in Chapter VI of his "Études de la Bière."

In a paper on the influence of oxygen on alcoholic fermentation (*J. Chem. Soc.*, **61**, 369), attention was called by the author to the fact that some of the experimental results described appeared to be contradictory to Pasteur's theory. Further work on this subject has led him to think that a review of the experiments on which Pasteur's theory rests, in conjunction with the results of some of his own, will not be out of place at the present time.

Pasteur's experiments may be divided into two classes, one containing experiments which appear to have suggested his theory, the other containing experiments undertaken for the purpose of proving its truth. It is not proposed to discuss the experiments in the first class, as, although they demonstrate most important facts regarding the life and growth of yeast, they afford no proof that fermentation is a consequence of "life without air."

The attempted proof of this theory lies in those experiments by which Pasteur determines, under varying conditions of aëration, the proportion of the weight of the yeast formed to the weight of sugar fermented. This ratio, or proportion, of yeast to sugar is, Pasteur considers, an expression of fermentative power; and when considering the ratios established by different experiments, he treats them as comparable with each other. By thus comparing fermentative powers of yeast cells under varying conditions of aëration, he arrives at the conclusion that when aëration is perfect, fermentative power ceases, and when aëration is reduced, fermentative power increases: the *proof* of Pasteur's theory, indeed, rests upon this conclusion.

As so much turns on Pasteur's interpretation of the experimental results by which he determines fermentative power, it is desirable to test it as thoroughly as possible. The ratio of yeast formed to sugar fermented in any experiment is an expression of fermentative power; but if it is found desirable to *compare* fermentative powers determined from the results of two or more experiments, it becomes necessary to make sure that either the total fermentative power, or some known fraction of it, has been measured in each case, otherwise no true comparison can be made.

The ratios determined in Pasteur's experiments are used as though they represented the total fermentative powers of the yeasts concerned; but there is no evidence in support of this, and they may represent unknown fractions of the powers equally as well. In the majority of Pasteur's experiments the sugar used was completely fermented, and exhibition of fermentative power by the yeast was thus limited by the amount of the sugar originally present in the fermentable liquid; but there is no evidence that, under these conditions, the yeast had exerted all its fermentative power. If the amount of yeast formed during fermentation were in direct proportion to the sugar fermented, the ratio of yeast to sugar would remain constant, however much or little sugar were available; but experiments made by the author show conclusively that such is not the case. The amount of sugar available during fermentation is a factor that has but little influence on yeast increase; *there is, in fact, no direct proportion between weight of yeast formed and sugar fermented.* In order to show that the total fermentative power of yeast has not been measured in Pasteur's experiments, a fermentation was carried on under aërobic conditions until the sugar originally present was decomposed. Afterwards, using the principle of overcrowding as a means of preventing reproduction, the crowded cells were fed with more sugar. Feeding was carried on at intervals until the yeast had fermented three times the amount of sugar originally present at the beginning of the experiment, but no increase in the weight of yeast took place. Thus the fermentative power of the yeast was found to be at least threefold what it would have been if determined in the manner adopted by Pasteur. In most of Pasteur's experiments under aërobic conditions, the apparent deficiency in fermentative power of the yeast was doubtless due to the quantity of sugar on which the yeast could exert its power being limited in amount.

In two experiments Pasteur estimated fermentative power under aërobic conditions, the yeast being in contact with sugar at the termination of the experiment, viz., in his experiments carried on in shallow dishes in order to expose the yeast to the maximum aëration possible. Pasteur believed that, under these conditions, the fermentative power of yeast was reduced to such a point that practically the yeast was no longer a ferment, but lived the ordinary life of a fungoid growth in air. But these experiments are open to the serious objection that, as they were allowed to continue during but a limited time, a *time* factor is introduced. Pasteur himself maintains that *time* had nothing to do with fermentative power, yet it enters into the question when considering these experiments. Moreover, as cane-sugar was used in these experiments, it must have been inverted before being fermentable. The author finds that inversion proceeds very slowly under the conditions of Pasteur's experiments. As inversion must precede fermentation, and is a function of the yeast cell apart from that of fermentation (J. O'Sullivan, Trans., **61**, 593), Pasteur's measure of fermentative power in the experiments referred to is an expression of the action of the inversion and fermentation functions of yeast cells in a limited *time*. Under these circumstances no reliance can be placed in the figures Pasteur gives as representing the true fermentative power of the yeast.

Apart from the fact that Pasteur fails to prove the truth of his theory by comparing fermentative powers, his hypothesis is further weakened by the fact that none of the results of his experiments are contradictory to a hypothesis opposed to his. The aërobic and anaërobic life-history of yeast, as domonstrated by Pasteur, can be accepted without the truth of his hypothesis regarding fermentative being admitted. There is no *primâ facie* reason why the fermentation functions of yeast cells should not be exercised independently of the cells' environment, so far as the presence or absence of free oxygen is concerned; and nothing in Pasteur's experiments contradicts this.

37. "Observations on the influence of temperature on the optical activity of organic liquids." By Percy Frankland, Ph.D., F.R.S., and John MacGregor, M.A.

The authors, after referring to the few isolated observations by Pictet, Perkin, and others, give the results of the polarimetric measurements which they have made at different temperatures between 0° and 35° C. with some of the ethereal salts of active glyceric and diacetylglyceric acids. Owing to the comparatively unstable nature of the ethereal salts of glyceric acid, caution has to be exercised, or the effect of decomposition may be mistaken for the influence of temperature. It is shown that these glycerates have a tendency, especially at higher temperatures, to partially decompose into alcohol and glyceric anhydride, and the latter remaining in solution in the undecomposed ethereal salt and alcohol, causes an increase in lævorotation. By avoiding this source of error, however, it is shown that the rotation of methylic and ethylic glycerates undergoes very marked increase as the temperature rises, the increase being greater in the case of the methylic than in that of the ethylic compound. The influence of temperature on the rotation of the diacetylglycerates is considerably greater, and, owing to their stability even at high temperatures, they lend themselves better to observations of this kind than do the glycerates. The results obtained with the glycerates and diacetylglycerates have been summarised, whilst for comparison there are also recorded the corresponding figures calculated from Pictet's determinations made with the tartrates at 20° and 100° C.

In each of the three series of homologous compounds the percentage increase in rotation for a given rise in temperature is greatest for the methyl, and then for the ethyl, compound, whilst the higher members of each series exhibit in general successively smaller increments. Reference to the previous paper will show that it is precisely in the first few members of each series also that the addition of CH_2 causes the greatest increase in rotation, or, in other words, in those cases in which the degree of molecular dissymmetry is most increased by a rise of temperature, the dissymmetry is also most increased by an addition of CH_2, and *vice versâ.*

38. "The maximum molecular deviation in the series of the ethereal salts of active diacetylglyceric acid." By Percy Frankland, Ph.D., F.R.S., and John MacGregor, M.A.

The authors have previously shown that in the homologous series of the ethereal salts of active glyceric acid, the rotation is increased by each addition of CH_2 in passing from methylic glycerate to normal butylic glycerate, whilst higher in the series the further addition of CH_2, on the contrary, leads to a diminution in the rotatory power. This culmination of the rotatory power in the butylic glycerate is most strikingly exhibited by calculating what has been termed by Guye the *molecular deviation*, $[\delta]_D$, for each of the members of the series, according to the formula

$$[\delta]_D = \frac{\alpha}{L}\sqrt[3]{\frac{M}{d}},$$

in which α is the observed angle of rotation, L the length of the polarimeter tube, M the molecular weight, and d the density.

The authors show in the present paper that there is the same phenomenon of a maximum rotation in the series of the ethereal salts of diacetylglyceric acid, and that this maximum is again reached at much the same point in the series, for whilst the rotation rises successively in passing from methylic to isobutylic diacetylglycerate, the normal heptylic and octylic compounds already exhibit a falling off in the rotation. The curves representing the molecular deviation of the ethereal salts of glyceric and diacetylglyceric acids respectively are in fact found to be roughly parallel, each diacetylglycerate possessing a rotatory power which is in excess of the rotatory power of the corresponding glycerate by a difference which does not undergo much change throughout the series.

A particularly interesting feature in the series of diacetylglycerates is the circumstance that in the methyl compound there are two groups of equal mass, and again, in the ethyl compound, two other groups of equal mass attached to the asymmetric carbon atom, but these relations are not attended with any change of sign throughout the series.

The authors have also commenced studying the effect of replacing the hydroxylic hydrogen in glyceric acid by higher negative radicles than acetyl, and have found that whilst methylic dipropionyl glycerate is slightly inferior in lævorotatory power to methylic diacetylglycerate, methylic dibenzoylglycerate is powerfully dextrorotatory.

39. "The preparation of sulphonic derivatives of camphor. By F. Stanley Kipping, Ph.D., D.Sc., and William J. Pope.

The method which the authors have previously given (Trans., 1893, 548) for preparing the sulphonic chlorides of camphor and of its halogen derivatives, by acting on the sodium salts of the sulphonic acids with phosphorus pentachloride, is tedious and uneconomical. The crude, hygroscopic sodium salts do not crystallise from the impure solutions in which they are obtained after sulphonation, and during the process of drying they undergo partial decomposition; the resulting sulphonic chlorides are consequently very impure, and are only isolated with difficulty, the yield being comparatively small.

Requiring large quantities of the pure sulphonic chlorides in order to study the halogen derivatives of camphor, which may be obtained from them by the method indicated in a previous note, it seemed desirable, in the first place, to improve the mode of preparation. This was accomplished by employing the ammonium salts of the sulphonic acids, which, unlike the sodium salts, are anhydrous, crystallise comparatively readily, and are easily obtained in a pure condition, even from highly impure solutions. The crude sulphonic chlorides prepared from these salts contain but little impurity and are very easily isolated, the yield being nearly theoretical; the sulphonic bromides, which were very difficult to obtain from the crude sodium salts and phosphorus pentabromide, may be readily prepared from the pure ammonium salts.

Bromocamphorsulphonic bromide, $C_{10}H_{14}OBr\cdot SO_2Br$, prepared from ammonium bromocamphorsulphonate, crystallises in large, transparent, lustrous octahedra, and is quite different in crystalline form from the corresponding sulphonic chloride; it has no definite melting point, but decomposes at about 140° with evolution of sulphur dioxide forming a new *dibromocamphor*, which will be described later.

Chlorocamphorsulphonic bromide, $C_{10}H_{14}OCl\cdot SO_2Br$, obtained from the ammonium salt of chlorocamphorsulphonic acid, also forms large, colourless octahedra and undergoes decomposition when heated, giving a halogen derivative, which is being investigated.

Camphorsulphonic bromide, $C_{10}H_{15}O\cdot SO_3Br$, was prepared from the feebly active ammonium camphorsulphonic acid, as it was interesting to compare its behaviour with that of the inactive sulphonic chloride (Trans., *loc. cit.*); the crude product seems to consist of a mixture of optically active and inactive substances, as in the case of the sulphonic chloride, but the existence of a definite racemic modification has not yet been established.

40. "Dextro-rotatory camphorsulphonic chloride." By F. Stanley Kipping, Ph.D., D.Sc., and William J. Pope.

Dextro-rotatory camphorsulphonic chloride has been previously described, but, owing to the great difficulty experienced in separating even a few grams of this substance from the inactive modification, it was not possible to make as complete a study of its derivatives as appeared desirable. It has now been ascertained that this optically active sulphonic chloride may be prepared in almost any quantity from the ammonium salt of bromocamphorsulphonic acid; when the latter is reduced with zinc dust and ammonia, it is rapidly converted into the ammonium salt of dextro-rotatory camphorsulphonic acid, from which the sulphonic chloride may be obtained by acting with phosphorus pentachloride (see preceding note). The product crystallises in colourless, transparent tetrahedra melting at 137·5°, and is shown to be identical with the optically active sulphonic chloride already described, not only by these properties but also by crystallographical measurements. Its production in this way not only makes it possible to push the investigation of its derivatives further, but is also of theoretical interest, inasmuch as it proves that on sulphonating either camphor or bromocamphor the sulphonic group becomes united with one and the same carbon atom, unless the highly improbable assumption be made that camphor contains two similarly orientated groups from which hydrogen may be displaced.

Dextro-rotatory camphorsulphonic bromide, $C_{10}H_{15}O\cdot SO_2Br$, has also been prepared in a similar manner; it crystallises in well-defined transparent octahedra, isomorphous with the crystals of the active sulphonic chloride, and resembles the latter very closely in ordinary properties.

The halogen derivatives obtained by heating these two active compounds will be described later.

41. "On the combination of chlorine with carbon monoxide under the influence of light." (Preliminary Notice.) By Gibson Dyson, Ph.D., and A. Harden, Ph.D., M.Sc.

Equal volumes of chlorine and carbon monoxide were mixed by diffusion in an apparatus consisting of two cylindrical bulbs with water jackets, connected by a capillary tube with a gauge containing sulphuric acid, the space above the acid being filled with carbonyl chloride, so that only the two gases and the product of their combination were present.

The action of light upon the mixed gases was studied by burning a measured piece of magnesium ribbon at a constant rate and at a measured distance in front of one of the bulbs, and observing the movement of the acid in the gauge. As soon as equilibrium was restored, a second piece of magnesium was burned and the gauge again observed. It may be assumed that in these experiments rise of the acid in the capillary tube of the gauge is proportional to the amount of combination produced. The experiments hitherto carried out show that when a mixture of equal volumes of the two gases, half saturated with moisture, is exposed to the action of the light from burning magnesium ribbon, there is a *well marked period of photochemical induction.*

This is illustrated by the following numbers, taken from one of our numerous experiments, which give the rise of the acid in the gauge in scale divisions caused by successive equal amounts of light.

	Scale Divisions.
1	1
2	8·5
3	18
4	20
5	24
	Constant.

The action of light upon exactly equivalent volumes of the two gases under various conditions is now being investigated, and experiments are being made on the combination of chlorine with other gases. We hope at no distant date to be able to lay the results of these experiments before the Society.

42. "Solution and pseudo-solution." Part II. By S. E. Linder and Harold Picton.

This is a continuation of previous work by one of the authors on arsenious sulphide solutions. The previous series of arsenious sulphide solutions has been extended, a solution having been prepared by the action of sulphuretted hydrogen on more dilute arsenious acid, which is filterable through a porous pot in addition to being diffusible. The following different solutions have now been prepared: As_2S_3 (α), with aggregates visible under microscope; As_2S_3 (β), invisible, but not diffusible; As_2S_3 (γ), diffusible, but non-filterable; As_2S_3 (δ), diffusible and filterable, but showing a polarised beam in Tyndall's experiment.

The following experiments have been made with the "higher grade" solutions (γ and δ).

1. Coagulative Power.—Metallic salts are found to arrange themselves in sharply-divided groups as regards their power of coagulating solutions of arsenious sulphide. The group into which a metallic salt will fall depends on the valency of the metal. The trivalent metals have the highest coagulative power, divalent metals about one-tenth, and monovalent metals less than one five-hundredth of this power. These differences are also shown by the same metal (*e.g.*, iron) when exhibiting varying valencies. The negative group also causes variation, and it is noteworthy that the coagulative power of the halogens is very similar, and so, also, is that of the arsenic and phosphoric acid radicals.

The effect of successive additions of salts of the same group is a corresponding increase in the amount of coagulation, whilst that of salts of different groups is to hinder coagulation, the latter effect attaining a maximum when a certain quantity of the first salt has been added. Thus if potassium chloride is first added and then strontium chloride, the addition of more potassium chloride increases up to a certain maximum the amount of strontium chloride required to complete the coagulation.

Certain applications of these results have suggested themselves. Thus, coagulative power might possibly be applied to check the valency of a metal in different compounds. Again, it is noteworthy that there is an unusual difference between the coagulative powers of free arsenic and phosphoric acids and their salts. It is also suggestive that free sulphurous acid differs widely in coagulative power from sulphuric acid, while sodium sulphite differs only comparatively slightly from sodium sulphate. Possibly relative coagulative powers may have an interesting bearing on questions of constitutional relationship.

2. Relative Density.—This varies quite regularly with dilution, the relation between relative density and dilution being represented by a straight line. This agrees with the results obtained with fairly dilute sugar solutions (9 per cent.), while strong sugar solutions (18 per cent.) and dilute salt solutions (0·2 per cent.) show a smaller diminution of relative density indicative of the formation of hydrates.

3. Volume-change on Coagulation.—It is found that when coagulation is conducted in a very sensitive apparatus, consisting of a flask of about 350 c.c. capacity fitted with a ground stopper carrying a capillary tube, there is absolutely no volume change on coagulation. Calcium chloride was used as the coagulant, and to eliminate the contraction produced by it, equal quantities of the same solution were used inclosed in thin glass bulbs. Two determinations with distilled water gave a volume change of 0·0177 and 0·0174 c.c. With the sulphide solution the contraction was 0·0175 c.c.

4. Surface-tension.—As determined by the rise of the solution in a capillary tube, the surface-tension of water is unaffected by the presence of dissolved arsenious sulphide. Cane-sugar, on the other hand, causes a small but distinct increase of surface-tension.

5. Osmotic Pressure.—The results of osmotic pressure measurements are very variable, but the authors think themselves justified in concluding that an osmotic pressure exists. Thus, a 4 per cent. solution has yielded a pressure of 17 mm. of water. No comparative determinations seem reliable, but a distinct pressure is always observed with diffusible solutions, but this is not observed with filterable substances. The smallness of the pressure would suggest exceedingly great molecular complexity.

Among new solutions examined may be mentioned the uranium and iron dextrosates, kindly placed at our disposal by Mr. Chapman. These scatter light and are non-filterable, but the iron compound, in presence of ammonia and ammonium chloride, does not scatter light and is filterable.

The complicated tungstate, $60WO_3 \cdot 3P_2O_5 \cdot V_2O_5 \cdot VO_2 \cdot 18BaO + 150H_2O$, does not scatter light and is filterable.

43. "Solution and pseudo-solution." Part III. By Harold Picton and S. E. Linder.

The authors describe further work on the electrical repulsion of certain solutions. The results are fully tabulated in the paper. It may be well to recall that if an attempt is made to pass a current through arsenious sulphide solution, the sulphide is repelled as a whole from the negative electrode, and also to a certain extent from the positive electrode, without appreciable electrolysis. A large number of solutions showing characteristic repulsions have now been investigated. Thus aniline blue (of various kinds) is repelled from the negative electrode, Magdala red and methyl violet from the positive, sulphur and iodine are repelled from the negative electrode.

It seems impossible to obtain repulsion in an absolutely non-conducting medium. For instance, iodine in carbon disulphide is not repelled. Again, on doubling the length of an arsenious sulphide column, the rate of repulsion is approximately halved. Indigo in water is repelled from the negative, in naphtha it is not repelled.

In general, when solutions exhibiting opposite repulsions are mixed, complete coagulation of the dissolved substance occurs. Under certain conditions of dilution the coagulation may be avoided, but in this case the mixture descends to a lower "grade" of solution. The aggregates of this "lower grade" solution are repelled as a whole from one electrode. Further, in two suitable cases the experiment was made of adding a new solvent (alcohol). The aggregates of the "lower grade" mixture were then found to dissociate and to be repelled individually from their characteristic electrodes. These facts are all illustrated by the cases of aniline blue mixed with Magdala red, and aniline blue mixed with methyl violet. Aqueous solutions of aniline blue with weak alcoholic Magdala red coagulate; aqueous aniline blue with aqueous Magdala red yield a "lower grade" solution, which is repelled from the negative electrode unless the Magdala red is much in excess. On dissolving the coagulation of (1) in strong alcohol, a higher grade solution is obtained, in which the aniline blue and Magdala red are repelled separately.

If a degraded solution of two oppositely repelled substances is taken, *e.g.*, an aqueous solution of aniline blue and methyl violet, on adding a third substance (*e.g.*, ferric hydrate) the combined aggregates in the solution are carried down as wholes, and the result is that all three substances separate out. On the other hand, if we take an alcoholic and dissociated solution of aniline blue and methyl violet, on adding ferric hydrate (positive) only the aniline blue (negative) is carried down, while the methyl violet (positive) is left in solution. This affords an additional test of "degradation" where the optical test fails. Thus aniline blue in alcohol with ferric hydrate in alcohol do not combine, for on coagulating with potassium sulphate only the ferric hydrate is carried down. The aqueous solutions do combine, as is shown by the potassium sulphate causing both to separate. Filtration also affords a test of combination. Thus arsenious sulphide (positive or negative) does not coagulate with aniline blue (negative), but combination occurs, as on filtering no aniline blue passes through the porous pot.

APPOINTMENT OF ASSISTANT SECRETARY AND LIBRARIAN.

The Council of the Chemical Society having decided to appoint an Assistant Secretary and Librarian, applications are now invited for this office. They should be sent to the Secretaries, at Burlington House, not later than July 25th. The Assistant Secretary will be provided with assistance in the Library, and will be required to devote his whole time to the duties of the office.

The salary will be £150 per annum, rising to £200.

Candidates will be expected to produce evidence of having received a chemical training.

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PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

No. 142 Session 1894–95.

Extra Meeting, June 28th. Dr. Armstrong, President, in the chair.

This meeting was held in the Theatre of the Royal Institution, by kind permission of the Managers.

The following paper was read and experimentally illustrated.

*44. "Phosphorescence and photographic action at the temperature of boiling liquid air." By James Dewar, F.R.S.

Phosphorescence and fluorescence are terms applied to similar phenomena which apparently differ only in degree, the first lasting for a relatively long period after the withdrawal of the light stimulus, whereas the second is so short that it can only be observed during the continuous action of the exciting agent. In all cases the luminous effects called phosphorescence and fluorescence belong to a less refrangible part of the spectrum than the exciting rays. Phosphorescence may be regarded as a kind of fluorescence which lasts a long time after the excitation has ceased, and may be briefly defined as the phenomena observed when certain substances give out light through the transformation of absorbed vibrations of shorter period. The researches of Becquerel showed that the intensity of phosphorescence depended directly on the intensity of the stimulating light, and a factor of absorption and intensity as some coefficient representing molecular friction or damping. When phosphorescing sulphides of calcium are heated they increase in this light emission, whereas if cooled to −80° they cease altogether to be luminous, and if maintained at this low temperature for hours keep a latent store of light energy that may be again evolved on allowing the temperature of the sulphide to rise to the ordinary temperature. But while the temperature of −80° is sufficient to stop all sensible emission from previously-excited sulphide, it does not prevent an unexcited sulphide from *absorbing* light energy that can be evolved at higher temperatures. Having now the means of cooling substances to temperatures ranging from −180° to −200° by means of liquid air, a new study of phosphorescence seemed admissible. Under such conditions all known organic compounds are solids, and this condition of matter is specially favourable to phosphorescent phenomena.

The effect of temperature on phosphorescence is easy to observe by taking two portions of the same substance placed in similar very thin test tubes, cooling one of the specimens in liquid air, and then quickly exposing both samples side by side to the same light stimulation. If during the light excitation, caused by burning magnesium or a flash of the electric light, the eyes are carefully covered, then the comparative phosphorescence, if any, of the cooled and uncooled substance can be observed. In this mode of working the action of the very short wave-lengths of light are stopped by the opacity of glass, but the solid condition of all substances at the low temperature enables the use of glass to be abandoned when necessary. As a general rule it may be stated that the great majority of substances exhibiting feeble phosphorescence at ordinary temperature become markedly more active at these very low temperatures. Thus gelatin, celluloid, paraffin, ivory, horn, and indiarubber become distinctly luminous, with a bluish or greenish phosphorescence, after cooling to −180° and being stimulated by the electric light. Hydroquinone was more luminous than the isomeric resorcinol or pyrocatechol, and in the same way pyrogallol was faint compared with phloroglucol. All alkaloids forming fluorescent solutions become phosphorescent at low temperatures. The hydrocarbons, alcohols, acids, and ethers of the fatty series are all more or less active, and glycerin, sulphuric and nitric acids are all very bright, so also are concentrated hydrochloric acid and strong ammonia solution. Coloured salts generally show little activity, but a large number of colourless salts are very luminous. Water when pure is only feebly phosphorescent, but remarkably so when impure. Acetic acid and acetamide appeared fairly equal in luminosity; hippuric acid was very fine, as were most substances containing a ketone group. Lithium platinocyanide changed from white to red on cooling, and was excelled in phosphorescing power by yellow ammonium platinocyanide, which was exceedingly bright.

Definite organic substances possessing exceptional powers of phosphorescence when stimulated at −180 C. are acetophenone, benzophenone, asparagin, hippuric acid, phthalic anhydride, urea, creatine, urethane, succinimide, triphenyl methane, diphenyl, salicylic acid, glycogen, aldehyde-ammonia, &c. It will require long and laborious experiments, however, to measure the relative brightness of the phosphorescence of bodies belonging to definite series.

Remarkable results were obtained with an egg shell and a feather respectively. The egg shone brilliantly as a globe of blue light, and the feather was equally brilliant, its outline showing clearly in the darkened room. Other organic substances giving good results were cotton-wool, paper, leather, linen, tortoise-shell, and sponge, all phosphorescing brightly, as did also a white flower, a cultivated species of *Dianthus*. Coloured glasses and papers as a rule exhibit no phosphorescence, and when the alcohols are coloured by the addition of a trace of iodine, the luminous effect is destroyed. Milk was shown to be highly phosphorescent and much brighter than water. The white of egg has greater phosphorescing power than the yolk, white substances generally being superior in this respect to coloured ones. On cooling a layer of white of egg on the outside of a test tube to —190°, and then exposing it to a flash of the electric arc, the brilliancy of the phosphorescent light is very striking. The chloro-, bromo-, iodo-, sulpho-, and nitro-compounds, as a rule, show nothing, or are but faintly luminous. Amongst basic bodies nicotine is more luminous than quinoline or pyridine. Metals also phosphoresce, but in this case the action is due to some organic film deposited from the air, because it disappears on ignition. If the metal is subsequently touched, the phosphorescence re-appears.

So far as the examination has been carried, the two most remarkable classes of substance for phosphorescence are the platinocyanides amongst inorganic compounds, and the ketonic compounds, like acetophenone and ethyl phenyl ketone, and others of the same type, amongst organic. When ammonium platinocyanide is cooled with liquid air and maintained at this temperature by being immersed in the liquid while stimulated by exposure to a beam of the electric arc, it continues to glow in the dark with a feeble emission as long as the temperature is kept about —180°. On pouring off, however, the liquid air from the crystals so that the temperature may rise, then the interior of the test tube glows like a lamp from the sudden increase of light emissivity as the temperature rises. It seems clear from this experiment that similar initial light intensities being used for stimulating, the substance at this low temperature must have acquired increased power of absorption, and it may be that at the same time the factor of molecular friction or damping may have diminished. That the absorptive power of substances for light is greatly changed at low temperatures is proved by the change of colour in substances like oxide, iodide, and sulphide of mercury, chromic acid, &c., when cooled. Many quantitative photometric measurements must be made before the actual changes taking place in the conditions governing the phenomena can be definitely stated.

Along with these experiments on phosphorescence, a number of photographs have been taken at −180°, using various sensitive plates and films, and these have been compared with similar photographs taken at the same time under similar conditions at the ordinary temperature. The photographs have been examined by Captain Abney, who reports that the photographic action has been reduced by 80 per cent. at the temperature of −180°. If the photographic action is brought about by a chemical change, then it appears to be the only one that can be traced under such conditions, as substances having the most powerful affinities have no action on each other, and all voltaic combinations cease to give a current at such low temperatures. It is certain that the Eastman film cooled to −200° by the evaporation of air *in vacuo* is still fairly sensitive to photographic action. Much further work, however, will be required to reach a definite conclusion as to what is taking place when substances sensitive to photographic action are subjected to such conditions of temperature.

The following are the abstracts of papers received during the vacation, and published in the Transactions:—

45. "The magnetic rotation of compounds supposed to contain acetyl, or to be of ketonic origin. Part II." By W. H. Perkin, Ph.D., F.R.S. (Trans., 1894, 815.)

The following substances were examined as to their magnetic rotation:—Dimethylacetylacetone, allylacetylacetone, hydracetylacetone, ethylic monocarboxyethylacetoacetate, ethylic-β-ethoxycrotonate, methylic acetoacetate, methylic dimethylacetoacetate, ethylic dimethylacetoacetate, ethylic diethylacetoacetate, acetylacetone and acetic anhydride; while allylacetylacetone, hydracetylacetone, and ethylic ethoxycrotonate were examined as to their refractive and dispersive power. Details of the results are given in the paper. The author finds that dimethylacetylacetone behaves only as a ketone, and concludes that the values given in his previous paper (Trans., 1892, 800) for monomethyl and monoethyl-acetylacetone are a little too high. Allylacetylacetone is found to consist, at ordinary temperatures, of the unsaturated hydroxylic compound; at 95° it principally consists of the ketone. Acetylacetone is the unsaturated monhydroxylic compound, $CH_3\cdot C(OH)\colon CH\cdot CO\cdot CH_3$, and hydracetylacetone is the saturated compound $CH_3\cdot CH(OH)\cdot CH_2\cdot CO\cdot CH_3$.

Ethylic monocarboxyethylacetoacetate and ethylic-β-ethoxycrotonate are unsaturated compounds. The remaining substances show similar results to those previously obtained.

46. "Studies on citrazinic acid. Part III." By W. J. Sell, M.A., and T. H. Easterfield, M.A., Ph.D. (Trans., 1894, 828.)

On further examination of the product of the action of dilute sulphuric acid on isonitrosocitrazinic acid (Trans., 1893, 1047), the authors regard it as αα-diglutaric acid. They have also prepared and described αα′-diglutaric acid, anhydrodiglutaric acid, and examined the products of the nitration and sulphonation of citrazinic acid.

47. "Azo-compounds of the ortho-series. Part III." By Raphael Meldola, F.R.S., and Edgar S. Hanes. (Trans., 1894, 834.)

A description is given of the reduction of the acetyl derivative of β-naphthaleneazo-β-naphthol with zinc dust and acetic acid, and of the preparation of α-naphthaleneazo-β-naphthol, metanitrobenzeneazo-paracresol, and of benzene-β-azo-α-naphthol. The methods of attack are summarised under the heads of reduction, nitration, and bromination. The first give ambiguous results in the case of azo-compounds containing acid radicles, but might be expected to give definite evidence of the constitution of alkyl derivatives; the second gives very decisive information in the case of alkyl derivatives of the azo-naphthols; the third has proved to be inapplicable to oxyazo-compounds.

48. "Derivatives of anthraquinone. Part III." By A. G. Perkin, and F. Cope. (Trans., 1894, 842.)

An examination of the properties of β-methylanthraquinone and of its derivatives. In the course of the inquiry the following substances were prepared and described:—*m*-hydroxyanthraquinone, β-carboxylic acid, alizarin-β-carboxylic acid, nitroalizarin-β-carboxylic acid, and purpurin β-carboxylic acid. The latter product was compared with purpurin carboxylic acid or pseudopurpurin present in madder, and the distinction between the two was exceedingly well defined. The carboxyl group in these compounds is very stable.

49. "Colouring and other principles contained in mang-koudu." By A. G. Perkin and J. J. Hummel. (Trans., 1894, 851.)

Mang-Koudou is the root bark of *Morinda umbellata*, largely used in Java for producing fast reds in the native calico prints. The authors correct their previous statement (Trans., 1893, 1162), that its colouring matter was alizarin. and now show it to be morindone. They have isolated 11 distinct substances from the root, which also contains free acid, the nature of which has not yet been determined. No cane sugar was found, a distinction from chay root (*loc. cit.*) and from madder. Full details of the methods employed in extraction and separation are given, and the behaviour of the substance as a dye stuff is described.

50. "Phenylnaphthalenes. II. β-phenylnaphthalene." By F. D. Chattaway, B.A., and W. H. Lewis, B.A. (Trans., 1894, 869.)

β-Phenylnaphthalene can be synthesised by allowing sodium to act at about 140° on a mixture of chlor- or bromo-benzene and β-chlornaphthalene, or β-bromonaphthalene dissolved in zylene. The yield is poor, but the method shows the constitution of the hydrocarbon. The product, distilling between 300—380°, consists chiefly of β-phenylnaphthalene. A yield of 2—3 per cent. of the weight of β-chloronaphthalene used was obtained. Its properties are fully described. It melts at 101·5°, and boils at 345—6°. Its quinone was prepared, and is described.

51. "Preparation of β-chloronaphthalene." By F. D. Chattaway, B.A., and W. H. Lewis, B.A. (Trans., 1894, 875.)

β-Chloronaphthalene is best prepared from β-naphthylamine by diazotising it and converting the diazochloride into the chloro-derivative by means of cuprous chloride. As little water as possible should be present, and not more than 30 grams of β-naphthylamine should be used. The final yield of the pure substance is about 75—80 per cent of the theoretical. The action of phosphorus pentachloride on β-naphthol yields only about 10 per cent.

52. "Note on β-mercurydinaphthyl and ββ-dinaphthyl." By F. D. Chattaway, B.A. (Trans., 1894, 877.)

β-Mercurydinaphthyl. prepared by Otto and Dreher's method, is examined and described. The author confirms Behren's results. When distilled over red-hot soda lime, it yields, among other products. ββ-dinaphthyl, which is also described. The author is engaged in investigating the dinaphthyls and their derivatives.

53. "Reduction of paratolueneazodimethylaniline." By D. R. Boyd, B.Sc. (Trans., 1894, 879).

P. Jacobson and Kunz reduced benzeneazodimethylaniline with stannous chloride and hydrochloric acid, and isolated from the product a dimethyltriamidodiphenyl. As transformation into a semidine base was not observed, though the substituting group was in the para-position, it appeared possible that the action might take a different course if a substituted group were present in the second para-position also. This investigation has shown that paratolueneazodimethylaniline yields, on reduction, a semidine base in very considerable quantity. The paper gives an account of the method of preparing the paratoluene compound, its reduction, the isolation of the resulting base, its behaviour towards formic acid, benzil, nitrous acid, and its decomposition products when acted on with hydrochloric acid, which prove the base to be an ortho-semidine.

November 1st, 1894. Dr. Armstrong, President, in the Chair.

Messrs. H. Davies, J. T. Hewitt, R. E. Hughes, and E. Brooke Pike were formally admitted Fellows of the Society.

The President having pointed out that the Certificates of Candidates for election are now always printed *in extenso* and circulated in the "Proceedings" before the date of ballot, it was unanimously resolved by the Meeting that the reading of only the names of Candidates should be regarded as reading the Certificates.

Certificates were read for the first time in favour of Messrs. Frederick John Allen, Phœnix Chemical Works, Poplar; George H. Allibon, Earlsfort, Strandmillis Road, Belfast; John Allport, M.A., 32, Lancaster Park, Richmond, S.W.; Samuel William Allworthy, M.A., M.D., Mosaphir, Cavehill Road, Belfast; Stephane Barlet, B. ès. Sc., 47, Bassett Road, W.; James Boulton, Craford Mills; D. R. Boyd, B.Sc., Mason College, Birmingham; John Samuel Strafford Brame, 36, Howard Street, Gloucester; James Bruce, 10, Selwood Terrace, Fulham Road, S.W.; George William Burman, 9, Ebor Terrace, Woodhouse Hill, Hunslet, Leeds; William Bush, Eastgate Villa, Chepstow Road, Newport, Mon.; Ezra Catherall, Harecrofts, Wilsden, Bradford; Arthur Herbert Coote, 8, Laurel Terrace, Bradgate Road, Catford, S.E.; John William Deakin, Northwich; William Michael Doherty, Robert Street, Marrickville, Sydney, N.S.W.; Lewis Benjamin Saltwell Dutson, 14, Vicarage Place, Walsall; John Garwood Everett, 29, High Street, Windsor; Alfred Greeves, Southlands Training College, Battersea, S.W.; John Hall, Spring Bank, Leftwich, Northwich; Edward Haworth, B.Sc., Hyndburn Bridge, Clayton-le-Moors, Accrington; Albert Helms, Ph.D., 8, Bridge Street, Sydney, N.S.W.; Alexander Frederick Hogg, M.A., 73, Stanhope

Road, Darlington; George Cecil Jones, Fylton, Bristol; Bevan Lean, B.A., D.Sc., Dalton Hall, Victoria Park, Manchester; W. H. Lewis, B.A., The Laboratory, Exeter School; George William MacDonald, B.Sc., 15, Stanley Gardens, N.W.; Charles James Shaw Makin, 51, Earls Court Square, S.W.; James McCutcheon, Marchmont, Lanark, N.B.; Charles Butterworth Newton, Gas Works, Rotherham; Thos. Ormerod, Sackville Street, Burnley; James Proude, 13, Oak Terrace, Halifax; Gerald G. Quinn, 7, Albert Street, Newcastle, Staffs.; David Gibson Riddick, Stores Department G.E.R., Stratford, E.; Alfred George Scorer, Abercorn Lodge, Upper Hamilton Terrace, N.W.; Claude Smith, Havering, Romford, Essex; Albert Taylor, 2, Torkington Street, Edgeley, Stockport; William G. Wagner, 101, Leadenhall Street, E.C.; Robert Waterhouse, 101, Leadenhall Street, E.C.; William L. Warren, 12, Westland Row, Dublin; Christopher Wilson, The Grammar School, Manchester; Robert Hanbury Wilson, Washing Stocks Farm, Bromsgrove, Worcester; Alexander Poole Wilson, Maypole House, Knocklong, Co. Limerick; James Young, 4, Plumstead Common Road, Woolwich.

Of the following papers those marked * were read:—

*54. "The electromotive force of alloys in a voltaic cell." By A. P. Laurie, M.A.

This paper contains the results of determinations of the electromotive force of 16 of the 19 alloys alluded to in Matthiessen's paper on the conductivity of alloys (*Phil. Trans.*, **150**). The results obtained confirm Matthiessen's conclusion, that only one compound, the tin-gold alloy, exists among the 16, which are:—

Bismuth-tin, bismuth-lead, bismuth-gold, bismuth-silver, gold-silver, antimony-lead, cadmium-zinc, antimony-tin, lead-gold, lead-silver, lead-tin, lead-zinc, lead-cadmium, cadmium-tin.

In some cases the addition of a metal to the alloy results in displacement. Thus mercury decomposes the gold-tin compound, and zinc, added to copper-tin alloy, appears to replace the tin.

Discussion.

The President said that owing to the difficulty of obtaining information by purely chemical methods as to the relative affinities of the metallic elements and of the proportions in which they could combine together, observations such as those of Mr. Laurie were of peculiar interest. Apparently the chief difficulty in applying his method was to obtain suitable liquids capable of separately acting on the several alloys. In this respect purely physical methods seemed to be of wider application. Bearing in mind the close relationship of magnesium, zinc and cadmium, and of copper, silver and gold, it was especially important to extend the observations made on copper zinc alloys to all these metals, *i.e.*, to ascertain the behaviour of the several metals of the one group to the several metals of the other, since it may be possible in this way to determine the relative valencies of such metals.

Mr. T. Turner said that Mr. Laurie's experiments on zinc-copper alloys enabled us to correct a mistake in the results obtained by Mallet, and published in his "Construction of Artillery," in which it was stated that the alloy containing 33 per cent. of copper was tough and malleable, and that it was used for watch-makers' brass. This statement has been copied into the majority of the text books, but, as a matter of fact, the 33 per cent. alloy corresponds with Laurie's definite compound, and is weak and brittle. Determinations of the electromotive force of tin-copper alloys had also yielded very interesting results, and had led him (Mr. Turner) to the conclusion that the existence of only two definite tin-copper alloys had been proved, the evidence in the case of the third being much less satisfactory. This question he had dealt with in the article "Tin," in Thorpe's Dictionary.

*55. "A product of the action of nitric oxide on sodium ethylate." By G. W. MacDonald, B.Sc., and Orme Masson, M.A., D.Sc.

The authors describe the absorption of nitric oxide by an alcoholic solution of sodium ethylate, the chief product of the action being the sodium salt of an acid, $CH_2N_4O_4H_2$. This is a crystalline explosive compound, insoluble in alcohol, but soluble in water. From it are obtained various insoluble metallic salts, the most characteristic one being the sky-blue copper salt, $CH_2N_4O_4Cu$. The properties of some of these salts are described, as also those of the soluble ammonium salt and the unstable acid, obtained in solution by decomposing the copper compound with hydrogen sulphide; and reasons are advanced in support of the hypothesis that the acid is *methylene-di-hydroxy-nitrosamine*, $CH_2[N(NO)OH]_2$.

The sodium salt, obtained by W. Traube, and called by him the sodium salt of methylene-di-isonitramine, $CH_2(N_2O_2H)_2$ (*Ber.*, 1894, 1507), by the action of nitric oxide on acetone in presence of alcoholic soda, is apparently identical with that now described.

*56. "The incomplete combustion of some gaseous carbon compounds." By W. A. Bone, M.Sc., Ph.D., and J. C. Cain, D.Sc., B.Sc. (Vict.).

The authors have extended the work of Lean and Bone on the explosion of ethylene with less than its own volume of oxygen

(Trans., 1892, 873) to mixtures of (1) acetylene, (2) cyanogen and hydrogen, and (3) normal pentane, with an amount of oxygen insufficient to oxidise all the carbon present to monoxide.

The method adopted was to explode the mixtures in a long, leaden coil (except in the case of pentane, when a long glass tube could safely be employed), closed by steel taps, having at one end a glass firing-piece, and connected at the other end with a mercury manometer, so that any change in pressure on explosion could be observed. The chemical changes which would occur in such experiments would therefore be those of the "explosion wave." Both the original mixtures and the products were carefully analysed, using a modified form of the McLeod gas-analysis apparatus (see *Phil. Trans.*, 1884, Part 2), which is admirably adapted for accurate work.

On exploding mixtures of acetylene and oxygen at atmospheric pressure, an increase in pressure of about 400 mm. of mercury was in each case noted. The products contained acetylene, a saturated hydrocarbon (doubtless methane), hydrogen, carbon monoxide, dioxide, and nitrogen.

Analysis shows that when acetylene is exploded with half its volume of oxygen, the resulting interaction may be expressed by the equation $2C_2H_2 + O_2 = 2CO + 2C + H_2$.

On exploding a mixture of cyanogen and hydrogen with oxygen a considerable increase in pressure occurred. Carbon was liberated. It appears that practically none of the hydrogen was oxidised during the explosion. The hydrogen and nitrogen actually found agree very well with the assumption that all the oxygen combines with cyanogen to form the monoxide and free nitrogen, whilst the excess of cyanogen breaks up into carbon and nitrogen. The carbon monoxide found is 2 per cent. lower than that given by calculation; but it must be remembered that $1\frac{1}{2}$ to 2 per cent. of carbon dioxide is formed.

The most interesting point in connection with these experiments is, however, the formation of methane and acetylene. In one case the amounts of both these hydrocarbons were more than 1·7 per cent. The formation of methane and acetylene in these experiments must be due to the direct union of carbon and hydrogen at the high temperature of the explosion-wave. Acetylene, it is well known, can be synthesised directly from its elements, but up to the present time methane has not been so obtained. The authors, in an experiment, which however they wish to be regarded merely as a preliminary one, satisfied themselves that the synthesis of methane from its elements is not an impossibility. By heating pure sugar-charcoal (which had previously been heated strongly in a current of chlorine, and then in a current of pure hydrogen) contained in a porcelain tube to a white heat in a charcoal furnace, in a current of hydrogen containing a *mere* trace of hydrocarbon impurities, they found that 1·71 per cent. (mean of four well-agreeing analyses) of methane was produced. This experiment will be repeated and extended.

The formation of acetylene, together with Berthelot's observation that when acetylene was decomposed by shock (charge of fulminate) only 0·04 per cent. of it remained unchanged, incline the authors to the view that the acetylene found is due to reunion of dissociated carbon and hydrogen in or behind the explosion-wave.

A mixture of 1 vol. pentane with $2\frac{1}{4}$ vols. of oxygen was exploded in a long glass tube. The mixture being just over the "explosion limit," the shock was not very violent, and the flame travelled quite slowly down the tube. Carbon was deposited, and an increase in pressure amounting to 2 atmospheres was observed.

Carbon monoxide, carbon dioxide, acetylene and hydrogen were produced; the acetylene formed may be accounted for by the fact that carbon and hydrogen were undoubtedly liberated in the explosion at a high temperature.

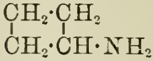
The experiments now described show that when a hydrocarbon containing n atoms of carbon is burnt with n atoms of oxygen, the interaction may be represented thus: $C_nH_x\,O_n = nCO + \frac{x}{2}H_2$, and that a mixture of cyanogen and hydrogen may be substituted for the hydrocarbon, thus: $C_2N_2 + H_2\,O_2 = 2CO + H_2 + N_2$.

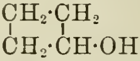
In addition to the various other issues raised by this work, the authors would draw attention to the formation of carbon dioxide in these experiments, as well as in those of Bone and Lean on ethylene, and also to the *amount* of carbon dioxide formed being *less* the *greater* the amount of oxygen (relative to the hydrocarbon) present.

DISCUSSION.

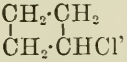
The PRESIDENT, referring to the stress laid by the authors on the production of less carbon dioxide when the greater proportion of oxygen was used, expressed the opinion that probably we were dealing with end results in such cases. It was conceivable that when more oxygen was used, and the temperature was consequently higher at some period during the explosion, the earlier dioxide became unburnt to a greater extent. If the authors were prepared to argue that acetylene was formed during the combustion of acetylene, they must also be prepared to admit that other reversed changes occurred.

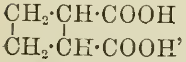
57. "Derivatives of tetramethylene." By W. H. Perkin, jun., F.R.S.

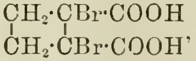
Contrary to the statement of Freund and Gudeman (*Ber.*, **21**, 2694), a good yield of *tetramethyleneamine*,  $\begin{array}{l} CH_2\cdot CH_2 \\ | \qquad | \\ CH_2\cdot CH\cdot NH_2 \end{array}$, is obtained when the pure amide of tetramethylenecarboxylic acid is attacked with bromine and potash. The base is a colourless, pungent-smelling oil, which boils at 81°, and is miscible with water, with evolution of heat; the *hydrochloride*, $C_4H_9N\cdot HCl$, crystallises in long striated needles; the *platinichloride*, $(C_4H_9N)_2\cdot H_2PtCl_6$, crystallises from water in deep orange octahedra.

Hydroxytetramethylene,  $\begin{array}{l} CH_2\cdot CH_2 \\ | \qquad | \\ CH_2\cdot CH\cdot OH \end{array}$, is produced when the hydrochloride of tetramethyleneamine is treated with silver nitrite; it is a colourless oil, which boils at 123°, and possesses an odour similar to that of butyl alcohol. When digested with hydrobromic acid it yields a mixture of *bromotetramethylene*, C_4H_7Br (b. p. 104°), and a *dibromobutane*, which boils at 174°, and which on investigation was found to be identical with 1 : 3-*dibromobutane*, $CH_3\cdot CHBr\cdot CH_2\cdot CH_2Br$, which the author succeeded in preparing by the action of hydrobromic acid on 1 : 3-dihydroxybutane (from aldol).

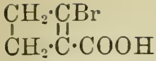
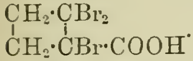
The formation of this dibromide shows that the tetramethylene ring, like the trimethylene ring, may, under certain conditions, be split by the action of hydrogen bromide, a behaviour of the four-carbon ring which has not before been observed.

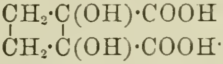
Chlorotetramethylene,  $\begin{array}{l} CH_2\cdot CH_2 \\ | \qquad | \\ CH_2\cdot CHCl \end{array}$, produced by the action of phosphorus pentachloride on hydroxytetramethylene, is a colourless oil, which boils at 85°, and which, when heated with potassium iodide in alcoholic solution, yields *iodotetramethylene*, C_4H_7I (b. p. 138°), an oil which, like the alkyl iodides, rapidly discolours in the air.

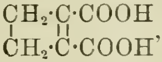
The action of bromine on tetramethylenedicarboxylic acid,  $\begin{array}{l} CH_2\cdot CH\cdot COOH \\ | \qquad | \\ CH_2\cdot CH\cdot COOH \end{array}$, has also been carefully investigated.

When this acid is heated with excess of bromine in the presence of phosphorus, the principal product of the reaction is *dibromotetramethylenedicarboxylic acid*,  $\begin{array}{l} CH_2\cdot CBr\cdot COOH \\ | \qquad | \\ CH_2\cdot CBr\cdot COOH \end{array}$, which crystallises in colourless plates, melts at 202—205° with decomposition, and is readily soluble in water; the *methyl salt*, $C_8H_{10}Br_2O_4$, melts at 88—89°, and the *anhydride*, $C_6H_6Br_2O_3$, at 103—104°.

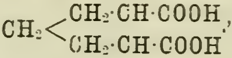
Alkalis, and also potassium iodide, convert dibromotetramethylenedicarboxylic acid into bromodihydrotetrenecarboxylic acid,

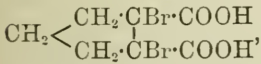
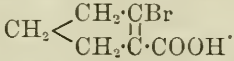
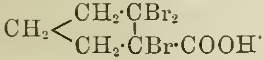
 $\begin{array}{l}CH_2\cdot CBr\\ CH_2\cdot C\cdot COOH\end{array}$ (colourless needles, m. p. 122°), carbon dioxide and hydrogen bromide being eliminated, and this acid, when exposed to bromine vapour, yields tribromotetramethylenecarboxylic acid,  $\begin{array}{l}CH_2\cdot CBr_2\\ CH_2\cdot CBr\cdot COOH\end{array}$.

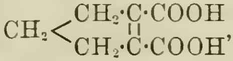
Silver hydroxide reacts readily with an aqueous solution of dibromo tetramethylenedicarboxylic acid, with formation of bromodihydrotetrenecarboxylic acid, and a syrupy acid, which appears to consist of *dihydroxytetramethylenedicarboxylic acid*,  $\begin{array}{l}CH_2\cdot C(OH)\cdot COOH\\ CH_2\cdot C(OH)\cdot COOH\end{array}$.

The action of alkalis on methylic dibromotetramethylenedicarboxylate is quite different from that described above in the case of the free acid, the principal product of the reaction being dihydrotetrenedicarboxylic acid,  $\begin{array}{l}CH_2\cdot C\cdot COOH\\ CH_2\cdot C\cdot COOH\end{array}$, a colourless, crystalline substance, which melts at 178°, and is not acted on by bromine at ordinary temperatures; at 200° it loses water, with formation of an anhydride.

Methylic dihydrotetrenedicarboxylate is formed quantitatively when methylic dibromotetramethylenedicarboxylate is digested in alcoholic solution with potassium iodide; it melts at 46°, and when exposed to bromine vapour is reconverted into the methylic salt of the dibromo acid.

58. "Pentamethylenedicarboxylic acid,  $CH_2\!<\!\begin{array}{l}CH_2\cdot CH\cdot COOH\\ CH_2\cdot CH\cdot COOH\end{array}$." By E. Haworth, B.Sc., and W. H. Perkin, jun., F.R.S.

When treated with bromine and phosphorus, pentamethylenedicarboxylic acid behaves very similarly to the corresponding tetramethylene compound (see preceding abstract), the principal product of the reaction being *dibromopentamethylenedicarboxylic acid*,  $CH_2\!<\!\begin{array}{l}CH_2\cdot CBr\cdot COOH\\ CH_2\cdot CBr\cdot COOH\end{array}$, a colourless, crystalline substance, which melts at 183—184°, and is readily decomposed by alkalis, forming *bromodihydropentenecarboxylic acid*,  $CH_2\!<\!\begin{array}{l}CH_2\cdot CBr\\ CH_2\cdot C\cdot COOH\end{array}$. This acid crystallises in needles, melts at 130°, and in contact with bromine vapour is converted into tribromopentamethylenecarboxylic acid,  $CH_2\!<\!\begin{array}{l}CH_2\cdot CBr_2\\ CH_2\cdot CBr\cdot COOH\end{array}$.

Dihydropentenedicarboxylic acid,  $CH_2\!<\!\begin{array}{l}CH_2\cdot C\cdot COOH\\ CH_2\cdot C\cdot COOH\end{array}$, is produced when methylic dibromopentamethylenedicarboxylate is digested in alcoholic solution with potassium iodide, and the product hydrolysed with alcoholic potash; it crystallises from water in colourless prisms, and melts at 178°.

A number of experiments are described in the paper, which were instituted with the object of preparing the anhydride of transpentamethylenedicarboxylic acid, a substance which, according to Baeyer's theory of anhydride formation (compare Trans., 1894, 572), should be capable of existence, and ultimately, by digesting the acid for 25 minutes with acetic anhydride, and distilling off the excess of the latter under reduced pressure, an oily product was obtained, which on examination was found to consist of the nearly pure anhydride of the trans-acid, and which on distillation was converted quantitatively into the anhydride of the cis-acid.

59. "Substituted pimelic acids." By A. W. Crossley, B.Sc., and W. H. Perkin, jun., F.R.S.

Some time since (Trans., **59**, 818) one of us, in conjunction with Mr. B. Prentice, described a method for preparing substituted pimelic acids, and it was shown that, by this method, it was only possible to obtain *αα'-di*substituted pimelic acids containing the same radicles as, for example, dimethyl pimelic acid,

$$COOH{\cdot}CH(CH_3){\cdot}(CH_2)_3{\cdot}CH(CH_3){\cdot}COOH;$$

in continuing the study of the pimelic acids various methods have since been tried with the object of preparing monosubstituted pimelic acids and disubstituted pimelic acids of the type

$$COOH{\cdot}CHR{\cdot}(CH_2)_3{\cdot}CHR'{\cdot}COOH,$$

containing dissimilar radicles.

When trimethylenechlorobromide reacts with the sodium derivative of ethylic ethylmalonate, ethylic ω-chloropropyl ethyl malonate, $(COOC_2H_5)_2{\cdot}C(C_2H_5){\cdot}CH_2{\cdot}CH_2{\cdot}CH_2Cl$, is obtained, and this substance when digested, in alcoholic solution, with the sodium derivative of ethylic malonate yields ethylic ethylpentanetetracarboxylate, $(COOC_2H_5)_2{\cdot}C(C_2H_5){\cdot}(CH_2)_3{\cdot}CH(COOC_2H_5)_2$, a colourless oil boiling at 275° (75 mm.). On hydrolysis, this ethereal salt yields a polybasic acid, which at 200° loses carbon dioxide forming ethyl pimelic acid, $COOH{\cdot}CH(C_2H_5){\cdot}(CH_2)_3{\cdot}CH_2{\cdot}COOH$, a colourless oil which boils at 260—265° (82 mm.); the *ethyl salt* boils at 198—200° (82 mm.); the *amide* is crystalline and melts at 145°.

Ethyl methylpimelic acid, $COOH{\cdot}CH(Me){\cdot}(CH_2)_3{\cdot}CH(Et){\cdot}COOH$, was also prepared, by a method which differs somewhat from that described above. The sodium compound of ethylic ethyl malonate was digested in methyl alcoholic solution with chlormethoxypropane,

$ClCH_2\cdot CH_2\cdot CH_2\cdot O\cdot CH_3$ (Trans., **15**, 596), and the resulting methylic methoxypropylethylmalonate, $(COOCH_3)_2\cdot C(C_2H_5)\cdot CH_2\cdot CH_2\cdot CH_2\cdot O\cdot CH_3$, a colourless liquid boiling at 180° (43 mm.) converted into the acid by hydrolysis.

This acid, on distillation, yields methoxypropanethylacetic acid, $COOH\cdot CH\cdot(C_2H_5)\cdot CH_2\cdot CH_2\cdot CH_2\cdot O\cdot CH_3$, which boils at 250°, and when treated with hydrobromic acid is converted into ω-bromopropylethylacetic acid, $COOH\cdot CH(C_2H_5)\cdot CH_2\cdot CH_2\cdot CH_2Br$.

The ethereal salt of this acid was then digested with the sodium compound of ethylic methylmalonate; the resulting ethylic ethyl methylpentanetricarboxylate, $CO_2Et\cdot CH(C_2H_5)\cdot(CH_2)_3\cdot C(CH_3)(CO_2Et)_2$, a colourless oil which boils at 227—230° (60 mm.), hydrolysed, and the tricarboxylic acid heated at 200°, until evolution of carbon dioxide had ceased. The residual crude acid, after distillation in vacuo after some months, deposited colourless crystals, which repeatedly recrystallised, melted at about 73°, and consisted of pure ethyl methylpimelic acid; the mother liquors from these crystals contain a lower melting acid, which is probably a stereoisomeride.

60. "Homologues of butanetetracarboxylic acid, and of adipic acid." By Bevan Lean, D.Sc., B.A., Bishop Berkeley Fellow of Owens College.

When acted on with sodium ethylate, ethyl butanetetracarboxylate forms a disodium derivative, which reacts readily with the iodides or chlorides of the alcohol radicles. A detailed study has been made of the dimethyl-, diethyl-, dicetyl-, and dibenzyl-derivatives so obtained.

These derivatives on hydrolysis yield tetracarboxylic acids, of the general formula $\genfrac{}{}{0pt}{}{HOOC}{HOOC}\!>\!CR\cdot CH_2\cdot CH_2\cdot CR\!<\!\genfrac{}{}{0pt}{}{COOH}{COOH}$, possessing some remarkable properties, which appear not to have been observed in the case of any other organic acids. These acids, although they contain four carboxyl groups, do not in all cases behave as tetrabasic acids. On determining their basicity by titration with potassium hydrate solution, some of them act as dibasic acids; notably is this the case with dibenzylbutanetetracarboxylic acid, the result being the same whether phenol phthalëin or litmus is used as the indicator. On the other hand, dimethyl-, diethyl-, and dicetyl-butanetetracarboxylic acids give different results, according as phenol phthalein or litmus is employed as the indicator. They appear tetrabasic with phenol phthalëin, while lower results are obtained with litmus solution. And, further, whilst the silver and calcium salts of dimethyl- and diethyl-butanetetracarboxylic are found to be tetrabasic, those prepared in the same way from dibenzyl- and dicetylbutanetetracarboxylic are found to be dibasic.

In connection with the apparently anomalous character of these tetracarboxylic acids, evidence is adduced from the work of Thomsen and Massol on the "Heat of Neutralisation of Acids," and of Ostwald Walker and others on the "Dissociation Constants of Acids" to show that the affinity of a polybasic acid is a complex function of the affinities of the several groups which it contains, and that the actions of one or more groups cannot be removed without affecting the affinities of the rest; and, in general, that the chemical character of a group of elements within a molecule depends not alone upon itself, but also upon the nature of those in the presence of which it is found.

The disubstituted butanetetracarboxylic acids, when heated at 200—210°, readily lose two molecules of carbonic anhydride, yielding disubstituted adipic acids, which invariably exist in two modifications, differing usually from one another in a marked manner in melting point, solubility, and other physical properties; for instance, dimethyladipic acids melt at 70—72° and 142°, diethyladipic acids melt at 51—53° and 136°, dibenzyladipic acids melt at 152° and 211—213°.

On heating the disubstituted adipic acids in sealed tubes with acetyl chloride, in no case was an anhydride obtained, but in view of the recent work of Manasse and Rupe (*Ber.*, **27**, 1818) on β-methyladipic acid it is possible that sufficient precautions were not taken to prevent the access of moisture from the air. Whilst, however, no anhydride was obtained, it was found that whether the higher melting or lower melting modification was employed, a partial conversion of the one into the other was effected, so that the product consisted of a mixture of the two.

61. "Contributions to the chemistry of cellulose. 1. Cellulose sulphuric acid and the products of its hydrolysis." By A. L. Stern, D.Sc.

When cotton cellulose is added to strong sulphuric acid, it dissolves; if the solution be diluted, neutralised with baryta, and filtered, a solution of barium cellulose disulphate is obtained. The free acid, $C_6H_8O_3(SO_4H)_2$, may be obtained by removing the barium by sulphuric acid; it is very unstable, and almost impossible to isolate. The barium salt may be obtained by concentrating its aqueous solution and adding alcohol, when it is thrown down as a syrupy precipitate, which may be dried by first dehydrating with strong alcohol, then exposing in a vacuum over sulphuric acid, and finally heating in a current of dry air at 100° until it ceases to lose weight. Thus obtained, it is a white or slightly-coloured glassy powder, very hygroscopic, soluble in all proportions in water, and precipitated from strong solutions by alcohol.

When an aqueous solution of cellulose disulphuric acid is boiled with dilute sulphuric acid, it is hydrolysed. This reaction takes place in two stages, which are, however, not sharply marked off from one another. In the first stage, sulphuric acid is eliminated, and the disulphuric acid is gradually converted into cellulose monosulphuric acid, $C_6H_9O_4\cdot SO_4H$, no other product being formed. In the second stage, cellulosic acids containing less sulphuric acid are formed, and also dextrose. The analytical results indicate the presence of only two of these acids, *i.e.*, $C_{12}H_{19}O_9\cdot SO_4H$ and $H\cdot C_{12}H_{18}O_9\cdot SO_4H$.

By no method of fractional precipitation was it possible to obtain any one of the barium salts of these acids in a state of purity although, when working with them, it was evident that their solubility in dilute alcohol differed. As the purified compounds contained molecular proportions of these salts, it was evident that they combine together. It was also frequently observed that the sugar combined with some of the salts, and thus explained the unsuccessful attempts to obtain it in a crystallisable condition. It was, however, undoubtedly dextrose.

The barium salts and free acids are all readily diffusible, and, when examined by Raoult's method, they give indications of a low molecular weight.

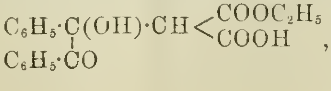
62. "The chlorination of aniline." By J. J. Sudborough, Ph.D.

The author finds that when chlorine is passed into a solution of aniline in chloroform to saturation, parachlor-, 2 . 4-dichlor- and 2 . 4 . 6-trichloraniline are formed.

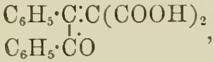
The preparation and properties of 2 . 4 . 6-trichlorbenzoic acid and 2 . 4 . 6-trichlorbenzoyl chloride are also described. The former crystallises from boiling water in long, prismatic needles, which melt at 160°. The acid chloride is an oil, which boils at 257° and is remarkably stable towards both boiling water and alcohol.

63. "Condensation of benzil with ethyl malonate." By Francis R. Japp, F.R.S., and W. B. Davidson, M.A., B.Sc.

By the condensing action of sodium ethoxide on a mixture of benzil and ethyl malonate, the authors have obtained two compounds: (1) the monethyl ester of benzoïnylmalonic acid,

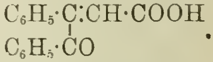


$$\begin{array}{l} C_6H_5\cdot\underset{|}{C}(OH)\cdot CH<^{COOC_2H_5}_{COOH}, \\ C_6H_5\cdot CO \end{array}$$

which crystallises in large, lustrous prisms melting at 134°, and yields a very sparingly soluble sodium salt; and (2) desylenemalonic acid,  $\begin{array}{l} C_6H_5\cdot C{:}C(COOH)_2 \\ \quad\;\, | \\ C_6H_5\cdot CO \end{array}$, which forms acicular crystals melting at 130°.

When the former compound is warmed with glacial acetic acid, it parts with water, and is converted into the monethyl ester of the latter.

Fuming hydriodic acid. at its boiling point, transforms desylenemalonic acid into a mixture of Victor Meyer and Oelkers' desylacetic acid (m. p. 160°) and Klingemann's diphenylcrotolactone (m. p. 151·5°), carbon dioxide being eliminated in the process.

When heated above its melting point, desylenemalonic acid parts with carbon dioxide, yielding desyleneacetic acid,  $\begin{array}{l} C_6H_5\cdot C{:}CH\cdot COOH \\ \quad\;\, | \\ C_6H_5\cdot CO \end{array}$. This substance was obtained in two forms, melting respectively at 150° and 168°, both of which gave, on analysis, figures agreeing with the foregoing formula; but the authors incline to regard this as due to dimorphism rather than to stereoisomerism, as the former modification, on keeping, spontaneously changed its melting point, and, after a lapse of two or three weeks, melted, like the latter, at 168°.

ADDITIONS TO THE LIBRARY.

I. *Donations.*

Essays in Historical Chemistry. By T. E. Thorpe, Ph.D., F.R.S. xi + 381 pp. London, Edinburgh [printed], 1894. 8vo.
By the Author.

Elements of Chemistry. By Andrew Fyfe, M.D. 2nd edition. xxiv + 1062 pp. Edinburgh 1830. 8vo. By Hy. Bassett, Esq.

Elements of Chemistry. By J. Murray. 2 vols. Edinburgh 1801. 8vo. By Hy. Bassett, Esq.

Corso Analitico di Chimica di G. Mojon. 2 vols. Genova 1825. 8vo. By Hy. Bassett, Esq.

Recherches sur les Rapports Réciproques des Poids Atomiques. Par M. J.-S. Stas. 134 pp. With autograph of author. Bruxelles 1860. 8vo. By William Crookes, Esq., F.R.S.

A Laboratory Guide and Analytical Tables, for junior students. By James Grant. 49 pp. Manchester 1894. 8vo.
By the Author.

Fertilisers and Feeding Stuffs: their properties and uses. By

Bernard Dyer, D.Sc. With the Fertilisers' Act, 1893, and notes on the Act by Alex. J. David. viii + 122 pp. London 1894. 8vo.
By the Author.

Practical Pocket-book of Photography. By Dr. E. Vogel. Translated by E. C. Conrad, F.C.S. x + 202 pp. London 1893. 12mo.
By the Translator.

A Practical Treatise on the use of the Blow-pipe in Chemical and Mineral Analysis. By John Griffin. xvi + 308 pp. Glasgow 1827. 12mo.
By the Librarian.

The Electric Current, how produced and how used. By R. Mullineux Walmsley, D.Sc. xii + 764 pp. London 1894. 8vo.
By the Publishers.

Smithsonian Institution. Smithsonian Meteorological Tables. (Based on Guyot's meteorological and physical tables.) City of Washington, published by the Smithsonian Institution, 1893. 8vo. lix + 262 pp. From Smithsonian Miscellaneous Collections, Vol. XXXV (No. 844).

Annual Report, to July, 1892. xlviii + 811 pp. Washington 1893. 8vo.
By the Institution.

Smithsonian Institution. Bureau of Ethnology. Tenth Annual Report of the Bureau of Ethnology to the Secretary of the Smithsonian Institution, 1888–89. By J. W. Powell, Director (Vignette). Washington, Government printing office, 1893. 8vo. xxx + 742 pp., 54 pl.
By the Institution.

United States. Department of the Interior. (U.S. Geological Survey.) J. W. Powell, Director. Geology of the Eureka District, Nevada, with an Atlas. By Arnold Hague. Washington, Government printing office, 1892. 4to. xvii + 419 pp., 8 pl.
By the Survey.

United States. Department of the Interior. (U.S. Geological Survey.) J. W. Powell, Director. A Manual of Topographic Methods. By Henry Gannett, Chief Topographer. Washington, Government printing office, 1893. 4to. xiv + 300 pp., 18 pl.
By the Survey.

U.S. Geological Survey. Bulletin. Nos. 97—117. Washington 1893–94. 8vo.
By the Survey.

Mineral Resources of the United States. 2 vols. Washington 1892–93. 8vo.
By the Survey.

Andersonian Chemical Society, Glasgow. A short historical account of the Andersonian Professors of Chemistry and the work they have done. Closing Address. Session 1891–92, 6th May. By H. H. Browning, M.A. 46 pp. Glasgow 1894. Sm. 4to.
From the Society.

II. *By Purchase.*

A Text-book of Organic Chemistry. By A. Bernthsen, Ph.D. Translated by G. M'Gowan, Ph.D. Second English edition, revised and extended. xix + 596 pp. London 1894. 8vo.

Die Praxis des Organischen Chemikers. Von Dr. Phil. L. Gattermann. viii + 303 pp. Leipzig 1894. 8vo.

Chemie der Organischen Farbstoffe. Von Dr. R. Nietzki. Zweite Auflage. xi + 329 pp. Berlin 1894. 8vo.

Organic Chemistry. Part I. By W. H. Perkin, jun., Ph.D., and F. S. Kipping, Ph.D. 302 pp. London, Edinburgh [printed], 1894. 8vo.

Systematic Survey of the Organic Colouring Matters. By Drs. G. Schultz and P. Julius. Translated and edited, with additions by A. G. Green. ix + 205 pp. London, Edinburgh [printed], 1894. 4to.

The Chemistry of Wine. By G. J. Mulder. Edited by H. Bence Jones, M.D. xii + 390 pp. London 1857. 8vo.

Die Cellulosefabrikation. Practisches Handbuch. Von M. Schubert. viii + 230 pp. Berlin [ ]. 12mo.

Ein Natürliches System der Gift-Wirkungen. Von Dr. O. Loew. viii + 136 pp. München 1893. 8vo.

The Radical Theory in Chemistry. By J. J. Griffin, F.C.S. xiii + 575 pp. London 1858. 8vo.

Grundzüge der Chemie. Methodisch bearbeitet von Prof. Dr. R. Arendt. Vierte Auflage. xii + 313 pp. Hamburg [printed], Leipzig 1892. 8vo.

Jahresbericht über die Fortschritte in der Lehre von den Gährungs-Organismen. Von Dr. A. Koch. Erster — Dritter Jahrgang. 3 vols. in one. Braunschweig, Rudolstadt [printed], 1891–93. 8vo.

Jahrbuch der Chemie. Bericht über die wichtigsten fortschritte der reinen und angewandten Chemie. Herausgegeben von R. Meyer. III Jahrg. 1893. xi + 605 pp. Braunschweig 1894. 8vo.

The Natural History of Nitre: or, a philosophical discourse of the nature, generation, place, and artificial extraction of Nitre, with its virtues and uses. By W. Clarke. 93 pp. London 1670. 16mo.

Pharmaceutisches Centralblatt. (Continued as the "Chemisch-pharmaceutisches Centralblatt," and after as the "Chemische Centralblatt"). 25 vols. Leipzig 1840—64. 8vo.

The Alchemical Essence and the Chemical Element. An episode in the quest of the unchanging. By M. M. P. Muir. 94 pp. London 1894. 8vo.

Alembic Club Reprints. No. 1. Experiments upon Magnesia Alba, Quicklime, and other mineral substances. By J. Black, M.D. 1766—97). 47 pp. Edinburgh [printed], London 1893. 8vo.

Alembic Club Reprints. No. 2. Foundations of the Atomic Theory: comprising papers and extracts by John Dalton, W. H. Wollaston, M.D., and T. Thomson, M.D. (1802—1808). 48 pp. Edinburgh [printed], London 1893. 8vo.

Alembic Club Reprints. No. 3. Experiments on Air. Papers published in the Philosophical Transactions by the Hon. Hen. Cavendish, F.R.S. (1784–85). 52 pp. Edinburgh [printed], London 1893. 8vo.

Alembic Club Reprints. No. 4. Foundations of the Molecular Theory: comprising papers and extracts by John Dalton, Jos. Louis Gay-Lussac, and Amedeo-Avogadro (1808–11). 51 pp. Edinburgh [printed], London 1893. 8vo.

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Alembic Club Reprints. No. 6. The Decomposition of the Fixed Alkalies and Alkaline Earths. By Humphry Davy (1807–8). 51 pp. Edinburgh [printed], London 1894. 8vo.

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Alembic Club Reprints. No. 8. The Discovery of Oxygen. Part 2. Experiments by C. W. Scheele (1777). 46 pp. Edinburgh [printed], London 1894. 8vo.

Ostwald's Klassiker der Exakten Wissenschaften.

No. 21. Ueber die Wanderungen der Ionen während der Elektrolyse. Abhandlungen von W. Hittorf (1853–59). Erster Theil. Herausgegeben von W. Ostwald. 87 pp., 1 pl. Leipzig 1891. 8vo.

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No. 23. Ueber die Wanderungen der Ionen während der Elektrolyse. Abhandlungen von W. Hittorf (1853–59). Zweiter Theil. Herausgegeben von W. Ostwald. 142 pp., 1 pl. Leipzig 1891. 8vo.

No. 25. Unterredungen und Mathematische Demonstrationen über zwei neue Wissenszweige, die Mechanik und die Fallgesetze betreffend von Galileo Galilei. Herausgegeben von A. von Oettingen. 66 pp. Leipzig 1891. 8vo.

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No. 34. Photochemische Untersuchungen von R. Bunsen und H. E. Roscoe (1855–59). Erste Hälfte. Herausgegeben von W. Ostwald. 96 pp. Leipzig 1892. 8vo.

No. 35. Versuch die bestimmten und emfachen Verhältnisse aufzufinden, nach welchen die Bestandtheile der unorganischen Natur mit einander verbunden sind von J. Berzelius (1811–12). Herausgegeben von W. Ostwald. 218 pp. Leipzig 1892. 8vo.

No. 38. Photochemische Untersuchungen von R. Bunsen und H. E. Roscoe (1855–59). Zweite Hälfte. Herausgegeben von W. Ostwald. 107 pp. Leipzig 1892. 8vo.

No. 39. Die in der Atmosphäre vorhandenen Organisirten Körperchen, Prüfung der Lehre von der Urzengung. Abhandlung von L. Pasteur (1862). Uebersetzt von Dr. A. Wieler. 98 pp., 2 pl. Leipzig 1892. 8vo.

No. 40. Zwei Abhandlungen über die Wärme. Von A. L. Lavoisier und P. S. De Laplace. (Aus den Jahren 1780 und 1784.) Herausgegeben von J. Rosenthal. 74 pp. Leipzig 1892. 8vo. (in progress).

No. 42. Das Volumgesetz gasförmiger Verbindungen. Abhandlungen von Alex. von Humboldt und J. F. Gay-Lussac (1805-8). Herausgegeben von W. Ostwald. 42 pp. Leipzig 1893. 8vo.

Trois Traitez de la Philosophie Naturelle non encore imprimez. Le Secret Livre du Artephius; plus. Les Figures Hierogliphiques de N. Flamel, &c. 103 pp. Paris 1612. 4to.

Elektrochemie. Ihre Geschichte und Lehre. Von Dr. W. Ostwald. Lief. 1—4. Leipzig 1894. 8vo.

Bihang till Kongl. Svenska Vetenskaps-Akademiens Handlingar. Nittonde Bandet. Afdel. 1—4. Stockholm 1894. 8vo.

Electric Waves: being researches on the propagation of electric action with finite velocity through space. By Dr. Heinrich Hertz. Translation by D. E. Jones, B.Sc. xv + 278 pp. London 1893. 8vo.

Watts' Dictionary of Chemistry. Revised and entirely rewritten by M. M. P. Muir, M.A., and H. F. Morley, M.A., D.Sc. Vol. IV. London 1894. 8vo.

Micro-Organisms in Water: their significance, identification and removal. By Percy Frankland, Ph.D., and Mrs. Percy Frankland. xi + 532 pp. London 1894. 8vo.

Wöhler's Grundriss der Organischen Chemie von Dr. Rudolph Fittig. Elfte Auflage. xxiii + 455—1116 pp. Leipzig 1887. 8vo.

Chemische Präparatenkunde von Dr. Adolf Bender und Dr. Hugo Erdmann. Bd. 2. Stuttgart 1894. 8vo.

Adressbuch für die Deutsche Mechanik und Optik. Von Fr. Harrwitz. 404 + 104 pp. Berlin 1894. 8vo.

Minerva. Jahrbuch der gelehrten Welt. Dritter Jahrgang. 1893–94. Strassburg 1894. 12mo. xvi + 861 pp.

Descriptive Catalogue of Essential Oils and Organic Chemical Preparations. By F. B. Power, Ph.D , &c. New York 1894. 8vo. v + 96 pp.

At the next meeting of the Society, on Thursday, November 15th, the following papers will be read:—

(1.) The alkaloids of *Corydalis cava.* I. Corydaline, Part IV. II. Corybulbine. By Professor J. J. Dobbie and A. Lauder.

(2.) Sulphonic derivatives of camphor, Part II. By F. Stanley Kipping, D.Sc., and W. J. Pope.

(3.) Halogen derivatives of camphor. Part I. By F. Stanley Kipping, D.Sc., and W. T. Pope.

(4.) Dimethylpimelic acid. By F. Stanley Kipping, D.Sc.

(5.) Attempts to estimate sulphur compounds in the atmosphere. By W. H. Oates.

CERTIFICATES OF CANDIDATES FOR ELECTION AT THE NEXT BALLOT.

December 6th, 1894.

N.B.—The names of those who sign from "General Knowledge" are printed in *italics*.

Allen, Frederick John,

Phœnix Chemical Works, Poplar.

Manufacturing Chemist. Associate of the Royal College of Science, London, in Chemistry. Studied Science privately for one year, and then for three years at the Royal College of Science. Has been for 15 months and is now Chemist in the Laboratory of Messrs. Fredk. Allen & Sons, Phœnix Chemical Works, Poplar.

T. E. Thorpe.	W. Palmer Wynne.
Chapman Jones.	J. W. Rodger.
A. E. Tutton.	Jno. Allen.
William A. Tilden.	*David Howard.*
Thos. Tyrer.	*Wm. Pearce.*

Allibon, George H.,

Earlsfort, Strandmillis Road, Belfast.

Chemical Works Manager for Messrs. Richardson Bros. & Co., manure manufacturers, &c., Belfast. For three years Assistant to Alfred Smetham, Esq., F.I.C., F.C.S., &c., Analytical Chemist, Brunswick Street, Liverpool. For seven years Chemist to the Phospho Guano Company, Ltd., Seacombe, Cheshire. For two and a half years Chemist and Works Manager for Messrs. Richardson Bros. & Co., vitriol and manure manufacturers, Belfast.

G. T. Glover.	Alfred Smetham.
Bernard Dyer.	Edward Davies.

Conrad Gerland.

Allport, John,

32, Lancaster Park, Richmond, S.W.

Science Tutor. M.A. of Camb. Univ. Senior Op. Mathl. Tripos, 1879. Science Master in the Royal College, Colombo, teaching mainly Chemistry and some Physics, 1887-93. Studied advanced Quantitative Analysis and made Chemical investigations for session 1893–94 in the University College, Nottingham, and obtained the College prize in these subjects.

Frank Clowes.
R. Lloyd Whiteley.
Llewellyn L. Garbutt.
J. Bernard Coleman.
Edgar B. Truman.
S. J. Pentecost.
Henry Forth.

Allworthy, Samuel William,

Mosaphir, Cave Hill Road, Belfast.

Medical profession. M.A., M.D., T.C.D. Diplomate in State Medicine. Obtained Scholarship in Experimental Science (value £90) from Trinity College, Dublin. Member British Institute of Preventive Medicine, &c.

Robert Barklie.
A. Wynter Blyth.
Hugh Woods, M.D.
Theodore Maxwell, M.D., B.Sc.
A. H. McConnell.

Barlet, Stéphane,

47, Bassett Road, W.

Teacher. Bach. ès Sc. (Univ. Gall.). Senior Assistant Master and Lecturer on Physical Sciences and Chemistry at the Mercers' School, E.C. (4 years).

William Briggs.
Henry Durham.
Vivian B. Lewes.
W. Popplewell Bloxam.
Herbert Jackson.

Blackmore, Henry Spencer,

206, South 9th Avenue, Mount Vernon, New York, U.S.A.

Chemist (Experimenting and Investigating). Graduate of College of Pharmacy, N.Y. City. Assistant Chemist in Laboratory of McKessin & Robbins.

Arthur H. Elliott.
James H. Stebbins, jun.
Henry A. Mott.
C. F. Chandler.
Herbert Lloyd.

Boulton, James,

Craford Mills.

Manufacturing Chemist. In the Interest of trade as a Chemical Manufacturer.

G. Russell Beardmore.
W. C. Young.
Rudolph Messel.
F. E. Adams.
E. C. Henning.

Boyd, D. R.,

Mason College, Birmingham.

Demonstrator of Chemistry in Mason College, Birmingham. B.Sc., Glasgow University. Late "Donaldson" Research Scholar, Glasgow University.

Percy F. Frankland. G. G. Henderson.
Matthew A. Parker. Walter G. McMillan.
C. F. Baker.

Brame, John Samuel Strafford,

36, Howard Street, Gloucester.

Analytical Chemist. Served five years as Articled Pupil in the County Laboratory for Gloucestershire, and afterwards two years as Assistant. During this time was also Assistant Master in the Gloucester School of Science. Have also taken all the Chemistry Courses at the Royal College of Science, London.

T. E. Thorpe. George Embrey.
W. Palmer Wynne. J. W. Rodger.
William Tate.

Bruce, James,

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Student of Chemistry. An Associate in Chemistry (1st Class) of the Royal College of Science, South Kensington. At present engaged in Research work at the Royal College of Science.

T. E. Thorpe. William A. Tilden.
W. Palmer Wynne. Chapman Jones.
J. W. Rodger.

Burman, George William,

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Analytical Chemist. I am an Analytical Chemist, employed by the Leeds Steel Works, Ltd., where I have been for over six years. Studied at the Leeds School of Science and Technology, distinguishing myself, taking 1st Class Honours Chemistry, also hold certificate for the Chemistry and Manufacture of Iron and Steel.

J. Wertheimer. Ed. Rawlins.
E. H. Saniter. *Hugh Barclay.*
H. Broadbent.

Bush, William,

Eastgate Villa, Chepstow Road, Newport, Mon.

Principal of the Newport (Mon.) Technical Schools and Director of Technical Education for the County Borough of Newport. 1st

Class Honours and Medal in the City Guilds examinations in Photography, in Electrometallurgy, and in Iron and Steel Manufacture. Desires to become a Fellow in order to obtain the advantage of the library and periodicals, &c.

Geo. R. Thompson.	John Parry.
Lionel M. Jones	*J. W. Rodger.*

Wm. Tate.

Cameron, Alexander,

13, Stonenest Street, Tollington Park, London, N.

Analytical Chemist. Studied for two and a half years Practical and Theoretical Chemistry with Messrs. R. R. Tatlock, Readman, & Thomson, City Analysts, Glasgow. At present Chief Assistant to Mr. F. J. Lloyd, Analytical Chemist, London. Contributed paper on "The Estimation of Silica" to *Chemical News* for 13th April, 1894.

Fredk. J. Lloyd.	G. Smith.
James Cameron.	D. Corrie.
Robert R. Tatlock.	Wm. Rintoul.

Horatio Ballantyne.

Catherall, Ezra,

Harecrofts, Wilsden, Bradford, Yorks.

Headmaster Hebden Bridge Organised Science School. Associate of the Royal College of Science, London (Chemistry 1st Class). In the examination for the Associateship I obtained the third place in Class I in Organic and Analytical Chemistry, and the first place in Class I in Chemical Physics.

T. E. Thorpe.	W. Palmer Wynne.
J. W. Rodger.	A. E. Tutton.

William Tate.

Chambers, Joseph F.,

Grammar School, Dursley, Glos.

Headmaster. Student of the Royal College of Science, London. Lecturer on Chemistry under Gloucester County Council.

T. E. Thorpe.	A. E. Tutton.
Fred. J. Hambly	*William Tate.*

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8, Laurel Terrace, Bradgate Road, Catford, S.E.

Assistant to Professor Hodgkinson, Artillery College, Woolwich. Six and a half years Assistant to H. B. Baker, Esq., M.A., in

Chemical Laboratory. Dulwich College. London University 2nd Class Honours in Chemistry at Int. Sci., July, 1894. Published, as joint author, abstracts of two papers in Chem. Soc. Proceedings.

Walter A. Voss. W. R. E. Hodgkinson.
H. Brereton Baker. Walter N. Edwards.
John J. Pilley. F. H. Coste.

Deakin, John William,
Northwich.

Manufacturing Chemist. For 15 years a Manufacturing Chemist. Paid special attention to matters relating to preparation of pure chemicals. Conducted research in those matters which have bearing upon the bases used in Organic Research. I have also worked specially upon the Chemistry of Photography. Have also conducted research and practical work in the leather manufacture in connection with the treatment of salted hides.

Fredk. H. Bowman. J. J. Howitt.
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Douglas Herman.

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102, Spring Street, Bury, Lancs.

Head Teacher, Chemistry and Physics Departments, Municipal Technical School, Bury. Studied for two years at the Royal College of Science, South Kensington, London, under Professor Dr. E. Frankland, Professor F. Guthrie, Professor T. M. Goodeve, &c. Passed 1st Class in all Divisions of Chemistry. Holder of many 1st Class Teacher's Certificates of the Science and Art Department. Student for several years at Owens College, Manchester, in Chemistry, Physics, Theoretical Mechanics, Mathematics, German, &c. Member of the Society of Chemical Industry. Fellow of the Imperial Institute. I have been engaged teaching Chemistry, Physics, &c., for the last 15 years.

W. H. Barr, L.R.C.P.S. William Marshall.
Thos. Stenhouse. Wm. A. Knight.
Thos. W. Berry. *F. W. Westaway.*

Doherty, William Michael,
Robert Street, Marrickville, Sydney, N.S.W.

Assistant to Government Analyst, Sydney, N.S.W. Author of two papers contributed to the Australasian Association for the Advancement of Science—"Composition of Lucerne" and also "On the Food Value of the Cavendish Banana."

William M. Hamlet. John C. H. Mingaye.
J. H. Maiden. Edward H. Rennie.
George A. Byrn.

Duncan, Cecil Cooke,

Royal Agricultural College, Cirencester.

Demonstrator of Chemistry, Royal Agricultural College, Cirencester. Author of the following papers :—"The Production of Pure Metallic Copper in a Crystalline Condition," *Proc. Chem. Soc.*, 1890, p. 95. "Ueber die Diffusion von Sauerstoff und Stickstoff in Wasser." "Beiträge zur Kenntniss der Respiration der Fische," C. Duncan and F. Hoppe-Seyler. In Hoppe-Seyler's *Zeit. f. Physiol. Chem.*. **17.** Heft 2—3. 1892.

John M. Thomson. Herbert McLeod.
Herbert Jackson. G. S. Johnson.
Edward Kinch.

Dunn, Frederic,

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Analytical Chemist (Public Analyst to the city of Melbourne, South Melbourne, Collingwood, &c.). For ten years Senior Assistant to J. Cosmo Newbery, Esq. (Scientific Superintendent of the Industrial and Technological Museum, Melbourne). For many years Lecturer on Chemistry at the Scotch, Wesley, and Ormond Colleges. About two years Chief Inspector of Explosives, and Analyst to the Department of Mines, Victoria. For nine years Public Analyst to the cities of Melbourne, South Melbourne, Collingwood, Fitzroy, &c., which I still act for.

C. R. Blackett, J.P., Government Analyst, &c.
Ferd. von Mueller. Orme Masson.
J. B. Kirkland. John Joseph Eastick.

Dutson, Lewis Benjamin Saltwell,

14, Vicarage Place, Walsall, Staffordshire.

Lecturer on Organic Chemistry. 1881 to 1885, Student of Chemistry at Walsall Science and Art Institute. 1885 to 1887, Demonstrator of Chemistry at Bourne College, Quinton. Student of Chemistry at Birmingham and Midland Institute, &c. October, 1887, to June, 1888, Student of Chemistry at Normal School of Science. February, 1889, to October, 1889, glass and enamel analyst. September, 1890, to present time, Teacher of Chemistry at Walsall Science and Art Institute. Have obtained 1st Class Inorganic N.S.S., 1st Class Honours Pract. S. and A. D., 2nd Class Honours Theor. S and A. D.

T. E. Thorpe. W. R. Eaton Hodgkinson.
Chapman Jones. A. E. Tutton.
A. R. Gower.

Everett, John Garwood,

29, High Street, Windsor.

Pharmaceutical Chemist. Was a Student under Dr. Attfield, at the Pharmaceutical Society's School, and as a Pharmacist. Is desirous of keeping up his scientific Chemistry, and in order to do so is anxious to have access to current chemical literature.

John Attfield.	R. H. Parker.
W. H. Symons.	J. Napier.
Wyndham R. Dunstan.	*Thos. P. Blunt.*

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Fogg, Charles A.,

48, Kent Street, Bolton, Lancs.

Science Demonstrator at the Organised Science School, Bolton. Commenced my studies in Theoretical and Practical Chemistry at the Manchester Grammar School (Science Section), and continued afterwards at the Owens College, Manchester. Also studied Industrial Chemistry subjects at the Manchester Technical School. Instructor in Chemistry in the above Science School, having taught large classes in Inorganic and Organic Chemistry (Theoretical and Practical) for the past eight years. Technological Chemistry. Studied this subject (Theor. and Pract.) at Owens College, Manchester.

Jno. L. Whiteside.	George H. Hurst.
R. L. Taylor.	G. H. Bailey.
Francis Jones.	William B. Mason.

F. E. Adams.

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Shillingstone, near Blandford, Dorset.

Mining Engineer. First at Cooper's Hill Engineering College, where he studied Chemistry, then served under Geo. Attwood, F.C.S., &c., for three years, partly at nickel, cobalt, and copper works and laboratory at Sudbury, Ontario, Canada, and partly at the Gold Reduction Works at Fairview, British Columbia, where he was engaged in working the cyanide process of gold extraction, and engaged in assaying gold, silver, copper, and lead minerals and their products, &c.

George Attwood.	W. Pellew Harvey.
W. Bezant Lowe.	*W. H. Hudleston.*

Hugo Müller.

Greeves, Alfred,

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Research Assistant in Chemistry at Royal College of Science, London. Three years at the Sulphuric Acid and Chemical Manure Works of Messrs. Thos. Farmer and Co., North Woolwich. Two years at Finsbury Technical College. Associate of Royal College of Science, London, in Chemistry (1st Class).

T. E. Thorpe. R. Meldola.
William A. Tilden F. R. Japp.
W. Palmer Wynne.

Hall, John,

Spring Bank, Leftwich, Northwich.

Manager of salt works. Two years Student in the Owens College Laboratories. Engaged for 12 years in Chemical Industry.

H. B. Dixon. Sydney Young.
Arthur Harden. *G. H. Bailey.*
Arthur Smithells.

Haworth, Edward,

Hyndburn Bridge, Clayton-le-Moors, Accrington.

Fellow of the Victoria University (in Faculty of Science). 1st Class Honours (Chemistry) B.Sc. Examination, Victoria University. Scholar and Fellow of the Victoria University. Dalton Chemical Scholar of the Owens College. Author of two papers in *Journ. Chem. Soc.*

W. H. Perkin, jun. Arthur Harden.
G. H. Bailey. Wm. A. Bone.
H. B. Dixon.

Helms, Albert,

8, Bridge Street, Sydney, N.S.W.

Analytical Chemist. Ph.D.; late assistant to Dr. A. W. Hofmann and teacher in Chemistry at Berlin University; late Lecturer, Sydney University.

W. M. Hamlet. John C. H. Mingaye.
J. H. Maiden. Edward H. Rennie.
Edwin Quayle.

Higgs, Martin Stanger, F.E.S.,

Clarence House, Gloucester.

Metallurgical and Analytical Chemist. Pupil and assistant for five years to G. Embrey, Esq., Public Analyst to the city and county of Gloucester. Student in Metallurgical Department, Mason's Science College, Birmingham, during session 1890–91; obtained 1st Class Senior Certificate in Practical Metallurgy, under Dr. Tilden. Late Chemist to the Midland Coal, Coke, and Iron Company, Newcastle, Staffs., 1892–93, under Mr. H. Pilkington, F.C.S. At present Chemist to Richard Thomas and Company, Limited, Tin and Iron-plate Works, Sydney, Gloucestershire.

J. T. Ainslie Walker.
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George Embrey.
Herbert Pilkington.
W. W. J. Nicol.
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Hogg, Alexander Frederick,

73, Stanhope Road, Darlington.

Science Master in the Grammar School, Darlington. M.A. (Cantab.). Graduate in Science Honours; member of Sidney Sussex College. Four years' work as a Teacher of Chemistry to boys and adult classes.

F. H. Neville.
W. F. Keating Stock.
John M. Thomson.
Charles T. Heycock.
J. T. Dunn.
John Spiller.
Arthur Smithells.
Wm. Harkness.

Jones, George Cecil,

Fylton, Bristol.

Analytical Chemist. Associate of the City and Guilds Institute. For 18 months assistant to Messrs. Helbing and Passmore, Analytical Chemists.

Henry E. Armstrong.
Gerald T. Moody.
F. Stanley Kipping.
W. Palmer Wynne.
Arthur R. Ling.

Knight, James,

John Street School, Bridgeton, Glasgow.

Teacher (Head of Secondary Dept., John St. P.S., Glasgow). M.A., B.Sc. (Glasgow) in departments of Chemistry and Geology. Hunterian Medallist in Geology. Lecturer on Foods and Dietetics to the Glasgow School of Cookery, West-end School of Cookery. Lecturer on Physiology and Hygiene at the High School of Glasgow. Head of the Chemical Laboratory, John St. School.

John Ferguson.
J. T. Bottomley.
A. Humboldt Sexton.
G. G. Henderson.
James J. Dobbie.
Robert R. Tatlock.

Ladell, Richard S.,

4, Colquitt Street, Liverpool.

Chemical Assistant. Assistant to Dr. A. B. Griffiths, F.R.S.E., &c. Engaged in Chemical Research. Author of papers "On the

Essential Oil of Lemon" (*Chemical News*, vol. **69**, p. 20); and other papers, in course of publication, "On the Terpeneless Essential Oils." Joint author, with A. B. Griffiths, of paper "Sur une Ptomaïne extraite des Urines dans la Grippe" (*Comptes Rendus de l'Académie des Sciences*, Paris, tome **117**), &c.

A. B. Griffiths.
Alexander Hay.
W. Herbert Walden.
E. Frankland.
James Dewar.
H. Follows.
Lionel Cooper.
William Crookes.
Wm. Odling.
Playfair.

Lean, Bevan, B.A., D.Sc. (Lond.),

Dalton Hall, Victoria Park, Manchester.

Demonstrator in the Chemical Laboratories, Owens College, Manchester. Four years Student in Chemistry, Owens College. Three years researching at Owens College. Author of following papers in *Journ. Chem. Soc.*:—(1.) "The Behaviour of Ethylene on Explosion." (2.) "Some Homologues of Butane Tetracarboxylic Acid" (not yet published). In *Manch. Memoirs*:—(1.) "The Extension of Flame in Explosions." (2.) "The Transmission of Explosions across Air Gaps."

Harold B. Dixon.
Arthur Harden.
Wm. A. Bone.
W. H. Perkin, jun.
G. H. Bailey.
Gilbert J. Fowler.

Lewis, W. H.,

The Laboratory, Exeter School.

Senior Science Master, Exeter School. B.A., Oxon. Late Scholar of Jesus College. Honours in Natural Science Schools, Oxford. Formerly Lecture Assistant at the University Chemical Laboratory, Oxford.

W. J. Russell.
H. Lloyd Snape.
W. W. Fisher.
F. D. Chattaway.
D. H. Nagel.
V. H. Veley.

MacDonald, George William,

15, Stanley Gardens, N.W.

Research Student. Exhibition Scholar, 1851. Bachelor of Science. Scholar and Exhibitioner of the University of Melbourne. Has assisted the Professor in practical teaching of Chemistry.

William Ramsay.
John Shields.
John Norman Collie.
Edward C. Cyril Baly.
N. T. M. Wilsmore.

McCutcheon, James,

Laboratory, Carluke, N.B., or Marchmont, Lanark, N.B.

Lecturer on Chemistry and Agriculture to the County Council of Lanarkshire. For three years Lecturer on Chemistry and Agriculture for the County Council of Lanarkshire. During this period he has delivered 30 lectures on these subjects at Biggar, Carluke, Carnwath, East Kilbride (2 Sessions), and Lesmahagow (2 Sessions). During the ensuing session he has to deliver 30 lectures on Theoretical and Practical Chemistry and the Principles of Agriculture, at Biggar (2nd Session), Carluke (2nd Session), Carmunnoch, East Kilbride (3rd Session), and Strathaven. He has charge of, and lectures in, the County Council Laboratory at Carluke. Author of "Principles of Agriculture" (R. L. Holmes, Glasgow).

J. Falconer King. Robert Wallace.
T. Rhymer Marshall. *G. H. Gemmell.*
W. Ivison Macadam.

Makin, Charles James Shaw,

51, Earls Court Square, London, S.W.

Analytical Chemist. Formerly a Student of the Royal College of Science, South Kensington, where he has taken the full courses of instruction in Theoretical (Inorganic and Organic) Chemistry, and in Laboratory Practice.

T. E. Thorpe. W. Palmer Wynne.
J. W. Rodger. William Tate.
A. E. Tutton. Chapman Jones.
G. S. Newth. A. P. Luff.

Newton, Charles Butterworth,

Gas Works, Rotherham.

Civil Engineer. Gas and Water Engineer to the Corporation of Rotherham. Honours Medallist in Gas Manufacture, City and Guilds of London Institute. Engaged in the manufacture of gas, sulphate of ammonia, sulphuric acid, and analytical chemistry connected therewith; also in the collection and purification of water for the supply of 60,000 persons.

Thos. P. Blunt. Leonard Temple Thorne.
J. Holliday. Thos. Duxbury.
Henry Ellison.

Ormerod, Thos.,

Sackville Street, Burnley, Lancs.

Head Master, Carlton Road School, Burnley. Student in the

Chemical Laboratory of the Owens College for Sessions 1891–92, 1892–93. Inter. B.Sc. (London), 1st Division.

W. H. Perkin, jun. G. H. Bailey.
P. J. Hartog. G. J. Fowler.
J. M. Murray.

Proude, James,

13, Oak Terrace, Halifax.

Soap Works Chemist and Manager. 1st Certificate Prize and Bronze Medal for Soap Manufacture (City and Guilds), 1894. Chemistry Certificate, 1891–92. Interested in all that appertains to the chemistry of soap making.

W. H. Wood. Thos. Holgate.
Herbert W. Seely. Thorp Whitaker.
F. F. Bond, M.D. *W. H. Richardson.*

Quinn, Gerald G.,

7, Albert Street, Newcastle, Staffordshire.

Demonstrator in Chemistry and Physics at the Hanley Higher Grade School. 1st Class Associate (in Chemistry) at the Royal College of Science, 1890–93, and Prizeman in Chemical Quantitative Analysis. I have taught classes in Chemistry, 1888–89 and 1887–88, at the Manchester School Board's Science Classes, and was Demonstrator in Chemistry and Physics at the Norwich Higher Grade School, and now occupy a similar position at the Hanley Higher Grade School.

T. E. Thorpe. W. Palmer Wynne.
Chapman Jones. A. E. Tutton.
William Tate.

Riddick, David Gibson,

Stores Dept., Great Eastern Railway, Stratford.

Analytical Chemist. With Dr. Kinnaird Belford, Northumberland. For 12 years Chemist to Stores Department, Great Eastern Railway.

Chas. E. Eastick. William Newton, Ph.D.
R. H. Harland. B. E. R. Newlands.
John A. R. Newlands.

Saunder, Charles Stirling,

163, Victoria Street, Westminster.

Licentiate of Royal College of Physicians of London, 1887. Senior Prizeman in Chemistry at the Royal Grammar School, Lancaster, Midsummer, 1876. Queen's Prizeman in Chemistry (1st Class) in the Government Examination in Science, May, 1875. A 1st year's Demonstrator of Chemistry, Charing Cross Hospital, 1882.

F. A. Abel.	J. C. Butterfield.
Robt. N. Lennox.	Fred Braby.
John Attfield.	*Arthur J. Dickinson.*

Scorer, Alfred George,

Abercorn Lodge, Upper Hamilton Terrace. N.W.

Teacher of Agriculture and Science connected therewith. Member of the Royal Agricultural College (by examination). Holder of 1st Class Certificate in Senior Examination of Royal Agricultural Society of England. Have also passed the examination at Surveyors' Institution for the Professional Associateship, and am waiting election.

Edward Kinch.	J. Augustus Voelcker.
A. G. Bloxam.	James Muir.
G. German. jun.	*Henry J. Staples.*

Smith, Claude,

Havering, Romford, Essex.

At present engaged in research work relating to Agricultural Chemistry [R.S. Grant, 1894]. Formerly Student of Chemistry in King's College, London. Author of the following communications: "The Natural Oxy-Celluloses" and "Note on the Production of Furfurol." *Chem. Soc. Journal.* 65. 472. 479.

John M. Thomson.	R. Warington.
Herbert Jackson.	Chas. Fred. Cross.
Edward Bevan.	J. Augustus Voelcker.

E. W. Voelcker.

Taylor, Albert,

2, Torkington Street, Edgeley, Stockport.

Lecturer in Chemistry, Dyeing, &c., at the Stockport Technical School. Two years Lecturer in Chemistry and Physics at Littleborough Technical Institute. 1st Class Honours (Science and Art Department) in Theoretical and Practical Inorganic and in Practical Organic Chemistry, and 2nd Class Honours in Theoretical Organic Chemistry. 2nd Class Honours Practical Metallurgy, and 2nd Class Honours in Theoretical Metallurgy and in Physiography. Also 1st Honours in Wool Dyeing (City and Guilds of London Institute).

R. J. Brown. Walter M. Gardner. James Grant.

Geo. A. Shaw. J. Wild.

Vaux, Cuthbert,

11, Thornhill Park, Sunderland.

Brewer. 1st Prizeman. 2nd year Associateship of Science, Durham University, and University Certificate in Chemistry. Studied Bacteriology in Professor Jargenson's Laboratory, Copenhagen, with Certificate of Proficiency. Also studied at University College. Now partner and brewer in Messrs. Vaux & Sons, Sunderland.

Lawrence Briant. Arthur J. Starey.
Thos. Watson Lovibond. William Fowler.
Charles Ranken. *P. Phillips Bedson.*
Henry H. Whitehead.

Wagner, William G.,

101, Leadenhall Street, E.C.

Analytical Chemist. Now Practicing Analytical Chemist. Articled to H. W. Wallis, B.A., F.C.S., F.I.C., and former Assistant to Alfred H. Allen, F.I.C., F.C.S., and C. G. Moor, M.A., F.C.S.

H. W. Wallis, F.I.C. Alfred H. Allen.
Otto Hehner. Watson Smith.
C. G. Moor. *Frank L. Teed.*

Warren, William L.,

12, Westland Row, Dublin.

Analytical Chemist. For three years a Student in the Royal College of Science for Ireland in Chemistry, Assaying, &c. Analyst during the last 12 months to Messrs. Richardson & Fletcher, Chemical Manure Manufacturers, Dublin.

W. N. Hartley. Hugh Ramage. Ernest Clark.
W. E. Adeney. *Jos. Reddrop.*

Waterhouse, Robert,

101, Leadenhall Street, London, E.C.

Analytical Chemist. Articled five years to Alfred H. Allen, Esq., F.C.S., F.I.C., Sheffield. Attended lectures by W. C. Williams, Esq., B.Sc., Firth College, Sheffield, obtaining Chemistry Certificate. Eighteen months at the University of Jena, Germany, Lectures and Practical Chemistry by Dr. Knorr (who first prepared antipyrine). Assistant to Messrs. Allen & Moor. Now practising as Waterhouse & Wagner, Analysts, 101, Leadenhall Street, E.C.

Alfred H. Allen. Otto Hehner.
C. G. Moor. Arthur Colefax.
Wallis Jenkins. *Jas. Baynes.*

Wilson, Christopher,

The Grammar School, Manchester.

Laboratory Assistant and Assistant Lecturer in Chemistry. Assistant at the University Chemical Laboratory, Cambridge, from January 16, 1873, to August 31, 1880. Assistant Lecturer in Chemistry at the Beyer Chemical Laboratory, the Grammar School, Manchester, from September 1, 1880, and now.

Francis Jones.
W. J. Sell.
H. J. H. Fenton.
Alexander Scott.
Charles T. Heycock.
William French.

Wilson, Robert Hanbury,

Washing Stocks Farm, Bromsgrove.

Analytical and Agricultural Chemist. Author of papers "On the Composition of the Fen Soils of South Lincolnshire" (*Chem. News*, **70**, 153); "On Staffordshire Clay Ironstones" (*Chem. News*, **70**, 168), &c. At present time engaged in research work.

Harold Follows.
A. B. Griffiths.
Geo. A. Pingstone.
William Crookes.
H. J. Mousley.
Lionel Cooper.
Thomas A. Pooley.
James Dewar.
E. Frankland.

Wilson, Alexander Poole,

Maypole House, Knocklong, Co. Limerick.

Chemical Analyst. For three years Student at University College, Liverpool; then Student Assistant under Dr. J. C. Brown for two years; two years as Analyst to Messrs. Newton, Keates, & Co., St. Helens; and for the last 18 months Analyst to Maypole Dairy Company.

J. Campbell Brown.
W. Collingwood Williams.
Charles A. Kohn.
Herbert B. Stocks.
S. G. Rawson.

Wood, John Cundell,

3, Belford Terrace, Sunderland.

Medical Officer of Health. Lic. Col. Surgeons; Lic. Col. Physicians, L.M. Diploma in Public Health, Edinburgh. Fellow British Institute of Public Health. Fellow of Incorporated Society of Medical Officers of Health, &c.

John C. Hewlett.
C. T. Kingzett.
Charles Ranken.
R. H. Harland.
Jas. Baynes.

Young, James,

4, Plumstead Common Road, Woolwich.

Instructor of Chemistry, R.M. Academy, Woolwich. Associate Royal College of Science, London. Formerly Royal Exhibitioner and Royal Scholar R.C.Sc., Lond. Selected by Civil Service Commission for above appointment in 1889. Published a note "On the Action of Dry Sulphur Dioxide on Dry Salts" with Dr. Hodgkinson in B.A. Reports, 1892.

W. R. Eaton Hodgkinson. T. E. Thorpe.
Percy F. Frankland. G. D. Liveing.
Chapman Jones.

HARRISON AND SONS, PRINTERS IN ORDINARY TO HER MAJESTY ST. MARTIN'S LANE.

Issued 5/12/1894

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

No. 143. Session 1894–95.

November 16th, 1894. Dr. Armstrong, President, in the Chair.

Mr. A. E. Tanner was formally admitted a Fellow of the Society.

Certificates were read for the first time in favour of Messrs. John Melrose Arnot, The Bally Paper Mills, Calcutta; Edward Elliott, Messrs. Reckitt & Sons, Hull; Harry Harris, The Pulo Brani Smelting Works, Singapore; Richard Ernest Kenyon, Ashville College, Harrogate; George Holman Kingdon, B.A., Taddyforde House, Exeter; Alexander MacFarlane, Pat.t Street, Ancoats, Manchester; Arthur Marshall, 65, Fairholme Road, West Kensington, W.

Of the following papers, those marked *, were read.

*64. "Sulphonic derivatives of camphor. Part II." By F. Stanley Kipping, Ph.D., D.Sc., and William J. Pope.

In this paper the authors describe the sulphonic bromides and chlorides of camphor, bromocamphor, and chlorocamphor which have been referred to in previous notes (Proc., 1894, 163, 164). The behaviour of dextro-rotatory camphorsulphonic bromide has now been fully examined, and presents many features of interest.

Dextro-rotatory camphorsulphonic bromide, $C_{10}H_{15}O{\cdot}SO_2Br$, is obtained in large orthorhombic octahedra, the crystallographic constants of which approximate very closely to those of dextro-rotatory camphorsulphonic chloride (Trans., 1893, 548). The axial ratios of these sulphonic derivatives are as follows.

$$C_{10}H_{15}O{\cdot}SO_2Cl \quad a : b : c = 0{\cdot}9980 : 1 : 1{\cdot}0368$$
$$C_{10}H_{15}O{\cdot}SO_2Br \quad a : b : c = 0{\cdot}9816 : 1 : 1{\cdot}0249;$$

The substances are therefore isomorphous, and consequently possess the same constitution. The sulphonic chloride almost invariably crystallises in tetrahedra, which, however, exhibit the positive and negative hemi-octahedral forms; the hemihedral character of this substance is thus placed beyond doubt. The sulphonic bromide, on the other hand, usually crystallises in orthorhombic octahedra, which, from their geometrical form, would seem to be holohedral. The complete analogy between the bromide and chloride is demonstrated, however, by the fact that the bromide crystallises in tetrahedra on varying the conditions of crystallisation. A careful crystallographic comparison of the octahedral and tetrahedral forms of the sulphonic bromide showed conclusively that the difference between them is only one of habit, and is not due to a difference between their crystalline structures.

The inactive camphorsulphonic bromide which the authors have prepared has even less of the characteristics of a definite racemic modification than the corresponding sulphonic chloride. In the latter case the non-racemic nature of the compound could not be demonstrated; in the case of the sulphonic bromide, the evidence against the existence of a true racemic modification is much more definite. By crystallising the inactive sulphonic bromide from ethylic acetate solution it may be partially resolved into the two oppositely active constituents. Further, the solution deposits large butterfly-shaped twin crystals; on examining these, the two wings are found to consist of the two oppositely active modifications. The lævo- and dextro-isomerides therefore twin together without forming a true racemic modification.

*65. "Halogen derivatives of camphor." By F. Stanley Kipping, Ph.D., D.Sc., and William J. Pope.

Seven new halogen derivatives of camphor have been obtained by heating the sulphonic chlorides and bromides, which are described in the preceding and in other papers, at temperatures below 200°; the following is a list of the compounds thus prepared.

Dextrorotatory chlorocamphor, $C_{10}H_{15}OCl$; inactive chlorocamphor $C_{10}H_{15}OCl$. Dextrorotatory bromocamphor, $C_{10}H_{15}OBr$; inactive bromocamphor, $C_{10}H_{15}OBr$. Dichlorocamphor, $C_{10}H_{14}OCl_2$. Dibromocamphor, $C_{10}H_{14}OBr_2$. Chlorobromocamphor, $C_{10}H_{14}OClBr$.

The bromochlorocamphor, which is doubtless produced on heating bromocamphorsulphonic chloride has not yet been obtained in a state of purity, owing to the fact that secondary changes occur during its formation, giving rise to a somewhat complex product.

The dihalogen derivatives, and some of the monohalogen derivatives, notably the optically inactive bromocamphor, are very well characterised substances, and have been examined crystallographically; very interesting cases of dimorphism and of polymorphism have also been met with, and have been carefully studied.

*66. "Dimethylpimelic acid." By F. Stanley Kipping, Ph.D., D.Sc.

In preparing 2 : 6-diacetylheptane, for the purpose of studying its behaviour on reduction (Trans., 1893, **63**, 111), the author and Mackenzie obtained, as a bye-product, an acid of the composition $C_9H_{16}O_4$, which, judging from its method of formation, was to be regarded as $\alpha\alpha'$-dimethylpimelic acid, $CO_2H{\cdot}CHMe[CH_2]_3{\cdot}CHMe{\cdot}CO_2H$. This acid, after careful purification, was obtained in well defined crystals, melting at 80—81° (Trans., 1891, **59**, 569).

A short time after the publication of this paper a dimethylpimelic acid, having, doubtless, the same constitution as the compound just mentioned, was prepared by Perkin and Prentice (Trans., 1891, **59**, 818), and also by Zelinsky (*Ber.*, **24**, 3997); in both cases, however, the melting point differed from that given by the author and Mackenzie. Perkin and Prentice found the melting point to be 74—76°, and, being cognisant of the earlier observations, they repeatedly recrystallised their acid, but without effecting any change; Zelinsky, who appears to have overlooked the paper by the author and Mackenzie, gave the melting point as 71—73°, and having obtained at the same time an oily acid of the composition $C_9H_{16}O_4$, he suggested that the latter was a stereoisomeric form of the crystalline acid.

These statements having thrown some doubt on the accuracy of the observations made by the author and Mackenzie, and the whole matter being in an unsatisfactory condition, the $\alpha\alpha'$-dimethylpimelic prepared by the hydrolysis of ethylic dimethyldiacetylpimelate was again examined.

The crude crystalline product began to soften at 52—58°, and usually liquefied completely at about 70°; when repeatedly recrystallised the melting point gradually rose, and finally an acid melting at 80—81° was obtained in a state of purity; this acid was identical with that (m. p. 80—81°) previously described.

The crystalline fractions of lower melting point were found to have the same composition as the pure acid melting at 80—81°, a fact which indicated the presence of a stereoisomeric form, but all attempts to isolate such a compound by fractional crystallisation were unsuccessful. Portions melting from 55 to 70° were therefore treated with phosphorus pentachloride and aniline successively, and the products submitted to careful fractional crystallisation; in this way two anilides were isolated, one melting at 183—184°, the other at 154—155°, and on analysis both gave results agreeing with those required by the anilide, $NHPh\cdot CO\cdot CHMe\cdot[CH_2]_3\cdot CHMe\cdot CO\cdot NHPh$.

On hydrolysis they both gave an oily acid, which was ultimately obtained in well-defined crystals; the acid from the anilide of higher melting point was identical with the compound melting at 80—81°, whereas the product from the anilide melting at 154—155° was the sought for stereoisomeride, and melted at 74·5—75°.

αα'-Dimethylpimelic acid, like the lower members of the series, exists therefore in two physically isomeric modifications, but the two forms are so similar in properties that their separation is not easily accomplished.

It seems probable that the acid described by Perkin and Prentice is identical with the modification melting at 74·5—75°, but the melting point given by Zelinsky leaves the nature of his acid quite uncertain.

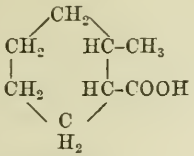
*67. "Hexahydro-o-toluic acid." By William Goodwin and W. H. Perkin, jun., F.R.S.

Some time since one of us, in conjunction with P. C. Freer (Trans., 1888, **53**, 208), prepared methylhexamethylene carboxylic acid (hexahydro-*o*-toluic acid) from the product of the action of methylpentamethylenedibromide on the sodium derivative of ethyl malonate, and described it as a colourless oil boiling at 235—236°. Recently Markownikoff has studied the reduction products of *o*-toluic acid, obtained by treating a boiling solution of the acid in amyl alcohol with a large excess of sodium, and has isolated a hexahydro-*o*-toluic acid, which boils at 240°, and solidifies on cooling, the melting point of the pure acid being 41°.

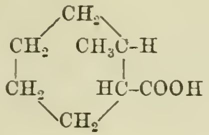
This wide difference in the properties of the synthetical acid and the acid obtained by reduction made it desirable to reinvestigate the whole subject, with a view of determining the reason of the isomerism, and in order to do this we have prepared considerable quantities of both the acids, and carefully re-examined their properties, with the result that we find that the two acids are undoubtedly isomeric; the synthetical acid does not solidify at −10°, whereas Markownikoff's acid solidifies at ordinary temperatures with the greatest ease.

The anilides of the two acids also differ in a marked manner, as the anilide of the synthetical acid melts at 66°, that of Markownikoff's acid at 140°.

An examination of the formula of hexahydro-*o*-toluic acid at once reveals the fact that this acid can exist in two stereoisomeric forms,

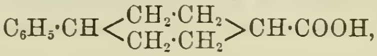


Cis-form.



Trans-form.

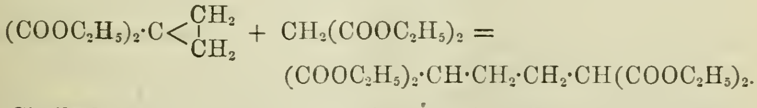
and it appears that the two acids mentioned above are in reality the two stereoisomeric forms of hexahydro-α-toluic acid.

This view is not improbable, since Baeyer and Rassow (*Annalen*, **282**, 140) have shown that the somewhat analogously constituted *p*-phenylhexahydrobenzoic acid,  $C_6H_5{\cdot}CH{<}{\substack{CH_2{\cdot}CH_2\\CH_2{\cdot}CH_2}}{>}CH{\cdot}COOH$, can be obtained in a cis and trans form.

In spite of a number of experiments, we have not succeeded in transforming the one modification into the other, probably because, owing to the low melting point of the solid acid, it would be exceedingly difficult to isolate it from admixture with the liquid acid.

*68. "The addition of the sodium derivative of ethylic malonate to ethylic trimethylenedicarboxylate." By W. A. Bone, Ph.D., and W. H. Perkin, jun., F.R.S.

If a mixture of ethylic trimethylenedicarboxylate with the sodium derivative of ethylic malonate be digested in alcoholic solution a sodium compound is formed, which, when decomposed with acids, yields ethylic butane tetracarboxylate; additions having taken place thus, with disruption of the trimethylene ring,



$$(COOC_2H_5)_2{\cdot}C{<}{\substack{CH_2\\|\\CH_2}} + CH_2(COOC_2H_5)_2 = (COOC_2H_5)_2{\cdot}CH{\cdot}CH_2{\cdot}CH_2{\cdot}CH(COOC_2H_5)_2.$$

Similarly, when the sodium derivative of ethylic methylmalonate is employed in this reaction, ethylic methylbutanetetracarboxylate is formed (b. p. 240—250° (55 mm.)).

This ethereal salt on hydrolysis yields the corresponding tetrabasic acid, which at 200° loses 2 mols. of carbon dioxide, and yields methyladipic acid, $COOH{\cdot}CH(CHz){\cdot}CH_2{\cdot}CH_2{\cdot}CH_2{\cdot}COOH$, a colourless, crystalline substance which melts at 64°, and is excessively soluble in water.

*69. "The reduction of chlorides of organic acids." By W. H. Perkin, jun., F.R.S., and J. J. Sudborough, B.Sc.

The authors have found that aldehydes and alcohols may be readily prepared from acid chlorides by acting on these in moist ethereal solution with sodium, the yield obtained, especially in the case of the chlorides of the fatty acids, being satisfactory.

The following substances have been obtained by this method.

n-Butyl aldehyde and *n*-butyl alcohol from *n*-butyryl chloride.
Isoamyl aldehyde and isoamyl alcohol from isovaleryl chloride.
Benzyl alcohol from benzoyl chloride.
o-Tolyl alcohol from *o*-toluic acid chloride.

This reaction is being carefully investigated in order to determine in what directions it is applicable, and with the object of finding the exact conditions for obtaining the best yields.

70. "$\beta\beta$-Ethyl methyl propionic acid, $C_2H_5CH(CH_3)CH_2{\cdot}COOH$." By W. H. Bentley, B.Sc.

This acid, which is required for some experiments in connection with the fusion of camphoric acid with potash, has not been described. Its preparation and properties form the subject of the present paper.

Methyl ethyl ketone was reduced by sodium in moist ethereal solution, and thus converted into methyl ethyl carbinol. This, when treated with iodine and phosphorus, yielded secondary butyl iodide, $CH_3{\cdot}CHI{\cdot}CH_2{\cdot}CH_3$, which has been prepared by de Luynes (*Bl.* 2, 3), who obtained it from erythritol by the action of hydriodic acid, and by Würtz (*Annalen*, **152**, 23), by the addition of hydriodic acid to normal butylene. It boils at 117—118°.

Ethyl secondary butyl malonate is formed when this iodide reacts with the sodium derivative of ethyl malonate. It distils at 228—231°, and when hydrolysed yields the corresponding dibasic acid, which on distillation is decomposed, with the formation of $\beta\beta$-methyl ethyl propionic acid, $C_2H_5CH(CH_3){\cdot}CH_2{\cdot}COOH$.

The pure acid boils at 196°, and possesses properties similar to those of the higher fatty acids.

In order to facilitate its identification, the following derivatives were prepared.

Ethyl salt, $C_5H_{11}{\cdot}COOC_2H_5$ a colourless oil, boiling at 157—158°.

Anilide, $C_5H_{11}{\cdot}CO{\cdot}NH{\cdot}C_6H_5$, crystallises from light petroleum in silky needles, m.p. 78°.

p-Toluide, $C_5H_{11}{\cdot}CO{\cdot}NH{\cdot}C_7H_7$, melts at 75—76°.

71. "The alkaloids of Corydalis cava. Corybulbine." By James J. Dobbie, M.A., D.Sc, and Alexander Lauder.

This alkaloïd is obtained from the commercial corydaline supplied by Schuchardt of Görlitz, by either of the following methods.

(1.) The crude material is dissolved in hydrochloric acid, and the solution mixed with excess of soda, which throws down the corydaline only. The filtrate is then saturated with carbon dioxide, when the corybulbine separates out.

(2.) The crude corydaline is repeatedly exhausted with hot alcohol, which dissolves out the greater part of the corydaline. The residue is dissolved in a large quantity of boiling alcohol, from which the corybulbine separates on cooling as an exceedingly fine crystalline powder. It is purified by conversion into the hydrochloride, which, after repeated recrystallisation from water, is decomposed by ammonia.

Corybulbine is nearly insoluble in water, soluble with difficulty in methyl and in ethyl alcohol, and insoluble, or nearly so, in ether. It dissolves readily in carbon bisulphide, chloroform, and hot benzene. It is also soluble in solutions of the caustic alkalis. An alcoholic solution of the alkaloïd rapidly reduces a warm solution of silver nitrate. When heated, corybulbine softens at 210°, but does not melt till 238—240°. A solution of the alkaloid in chloroform is dextro-rotatory.

Corybulbine has the formula $C_{21}H_{25}NO_4$. The hydrochloride, $C_{21}H_{25}NO_4{\cdot}HCl$, is obtained in clusters of prismatic needles by dissolving the alkaloïd in hot dilute hydrochloric acid. This salt is remarkable for the difficulty with which it dissolves in water.

The acid sulphate, $C_{21}H_{25}NO_4{\cdot}H_2SO_4$, is prepared in the same manner as the hydrochloride. It dissolves with difficulty in hot water, from which it slowly separates on cooling, in long prismatic crystals.

The platinochloride, $(C_{21}H_{25}NO_4)_2H_2PtCl_6$, is thrown down as a pale yellow precipitate on adding platinum chloride to a solution of the hydrochloride in water containing a little hydrochloric acid.

The methiodide, $C_{21}H_{25}NO_4{\cdot}CH_3I$, a pale yellow, crystalline substance, is prepared by digesting the alkaloïd with a mixture of absolute alcohol and methyl iodide.

When acted on with a concentrated solution of hydrogen iodide, one molecular proportion of corybulbine gives three molecular proportions of methyl iodide.

72. "Corydaline. Part IV." By James J. Dobbie, M.A., D.Sc., and Alexander Lauder.

When subjected to the action of nascent chlorine, corydaline forms a monochloro-derivative $C_{22}H_{28}ClNO_4$, which crystallises from water in flat, prismatic crystals.

The specific rotation of corydaline has been found to be +311°.

Oxidation with Potassium Permanganate.—The authors have examined the mother-liquor of corydalinic acid, and have obtained from it several new oxidation products. The mother liquor is neutralised with ammonia and precipitated with lead acetate. On decomposing the lead precipitate with sulphuretted hydrogen and concentrating the solution, a little corydalinic acid first separates out; a mass of crystals then slowly deposits which consists chiefly of hemipinic acid identical with that obtained from narcotine, mixed with a small quantity of a nitrogenous acid which has not yet been investigated. The mother liquor filtered from the lead precipitate slowly deposits crystals of a neutral substance having the formula $C_{11}H_{13}NO_3$. which contains two methoxy-groups, and is probably an oxy-derivative of dimethoxy-isoquinoline.

The further investigation of the action of hydrogen iodide on corydalinic acid has shown that the chief product of decomposition is protocatechuic acid.

The authors conclude from the results which they have obtained that corydalinic acid, $C_{11}H_5N(OCH_3)_4(COOH)_4$, contains both a benzene and a pyridine ring; that by the action of hydrogen iodide the benzene ring is split off in the form of protocatechuic acid, whilst the nitrogenous ring is broken up into ammonia and the non-nitrogenous corydalic acid described in a former paper. The appearance of hemipinic acid amongst the products of the oxidation of corydaline would be accounted for by the oxidation of the benzene ring of corydalinic acid. The analysis of the neutral compound shows that two of the methoxy-groups are attached to the pyridine ring of corydalinic acid. It is therefore probable that corydaline is an alkaloïd of the same type as papaverine, narcotine, and hydrastine, containing an isoquinoline and a benzene nucleus, but of simpler constitution than these alkaloïds, inasmuch as the two nuclei appear to be united directly to one another and not through an intervening carbon-atom.

73. "Attempts to estimate sulphur compounds in the atmosphere." By William H. Oates, 1851 Exhibition Science Scholar, Firth College, Sheffield.

The paper contains an account of attempts made to estimate the total amount of sulphur compounds present in the atmosphere of Sheffield.

Various forms of apparatus and different oxidising agents, such as hydrogen peroxide, sodium peroxide, iodine, and potassium permanganate, were tried, but in none of the experiments was it conclusively proved that all the sulphur compounds present in the air were oxidised and retained by the apparatus used.

The results of the determinations tend to show that the amounts of sulphur compounds present in the air, which have been previously published, are considerably too low, and that none of the forms of apparatus used in the experiments described are capable of yielding correct results.

At the next meeting, on Thursday, December 6th, there will be a ballot for the election of Fellows, and the following papers will be read:—

"The relative behaviour of chemically prepared and of atmospheric liquid nitrogen." By Professor Dewar, F.R.S.

"The use of the globe in the study of crystallography." By J. Y. Buchanan, F.R.S.

"The latent heat of fusion." By Holland Crompton.

"New Method of preparing dihydroxytartaric acid." By H. J. H. Fenton.

"Essential oil of hops." By A. C. Chapman.

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PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

No. 144. Session 1894–95.

December 6th, 1894. Dr. Armstrong, President, in the Chair.

Professor P. T. Cleve, of Upsala, Foreign Member of the Society, was present at the meeting, and signed the roll of Fellows.

Messrs. Arthur P. Hope, William F. Mawer, E. C. Thompson, and Arthur Ross were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. David Butler Butler, 41, Old Queen Street, Westminster, S.W.; Tom Crossman, 40, Coldhurst Street, Oldham; Frederic Weldon Daw, Bishop's Road, Ebbw Vale, Mon.; Weldon Hanson, 30, Baker Street, Middlesbro'-on-Tees; Walter Harris, B.A., Ph.D., Campbell College, Belfast; Hugh Hastings, 10, Yew Tree Road, Kidderminster; James Albert Offord, 46, St. Giles Street, Norwich; Thomas Chilwell Sharrott, Grendon Lodge, Atherstone; David John Williams, Ty Newydd Farm, Garn Dolbenmaen, Carnarvon; Evan Williams, Rochdale Road Gas Works, Manchester.

The following were duly elected Fellows of the Society: Messrs. Frederick John Allen; George H. Allibon; John Allport, M.A.; Stéphane Barlet, B.ès Sc.; Henry Spencer Blackmore; D. R. Boyd, B.Sc.; John Samuel Strafford Brame; James Bruce; George William Burman; William Bush; Alexander Cameron; Ezra Catherall; Joseph F. Chambers; Arthur Herbert Coote; William Michael Doherty; Cecil Cooke Duncan; Frederic Dunn; Lewis Benjamin Saltwell Dutson; Charles A. Fogg; Donald Gordon Forbes; Alfred Greeves; John Hall; Edward Haworth, B.Sc.; Albert Helms, Ph.D.; Martin Stanger Higgs; Alexander Frederick Hogg, M.A.; George Cecil Jones; James Knight, M.A., B.Sc.; Richard S. Ladell; Bevan Lean, B.A., D.Sc. (Lond.); W. H. Lewis, B.A.; George William

MacDonald, B.Sc.; Charles James Shaw Makin; James McCutcheon; Thomas Ormerod; Gerald G. Quinn; David Gibson Riddick; Alfred George Scorer; Claude Smith; Albert Taylor; Cuthbert Vaux; William G. Wagner; William L. Warren; Robert Waterhouse; Christopher Wilson; Robert Hanbury Wilson; Alexander Poole Wilson; James Young.

PROFESSOR DEWAR exhibited a vacuum-jacketted globe containing about half a litre of liquid air, which had been kept for the previous 30 hours at the Royal Institution.

Of the following papers, those marked * were read.

*74. "The relative behaviour of chemically prepared and of atmospheric nitrogen in the liquid state." By James Dewar, F.R.S.

When gases such as nitrogen, oxygen, or air are liquefied in large quantities, the impurities found in the gases and taken up during the passage through the pumps gradually accumulate, and when the fluids are discharged into vacuum vessels at atmospheric pressure these separate in the solid state. If the solid matter is filtered off from liquid air and the fluid allowed to evaporate slowly from a vacuum vessel, then the last drops of liquid are almost pure oxygen; nitrogen gas containing 3 or 4 per cent. of oxygen when liquefied behaves exactly in the same way. It would appear, therefore, that no impurity of higher boiling point than oxygen can be separated by ordinary fractional distillation of the liquid air, and if any other material is present it must evaporate along with the nitrogen. By the use of a special arrangement small quantities of gases, in a pure and dry state, amounting to from 100 c.c. to a few litres, may be examined in the liquid condition and the experiment repeated as often as desired with the same specimen of gas.

The simple apparatus exhibited, by means of which the condensing point of a gas and afterwards the volatilising rate of the resulting liquid may be observed, may be succinctly described as follows:—A tube of small bore, somewhat drawn out at one extremity, is passed nearly to the bottom of a distillation flask and sealed into the neck. The outer portion of this tube is closed and bent twice at right angles, so that a closed limb is thus formed outside the vessel. The side tube of the flask is sealed after the pure, dry gas under examination has been introduced, together with phosphorus pentoxide, at a known pressure and temperature. The closed limb of the small-bore tube is then cautiously introduced into a vacuum-jacketted tube containing liquid air or oxygen, so arranged that the vapour pressure on the liquid may be gradually lowered by means of an air-pump, and the gas within the tube slowly reduced to the temperature of liquefaction. In this way it is easy to observe the point at which liquid begins to form from different samples of gas placed side by side, and afterwards, when the temperature of the liquid air bath is allowed to rise, the point at which the last drops of the liquids resume the gaseous form. Nitrogen obtained from atmospheric air has been compared in this manner with nitrogen prepared from nitric oxide without any differences between them being detected. Atmospheric nitrogen which has been passed over heated magnesium showed, however, a marked difference as compared with gas which had not been so treated. Although its condensing point was not far removed from that of the untreated material, as a matter of fact this point, as well as the volatilising point of the resulting liquid, was higher than before, that is to say, nitrogen which has been passed over heated magnesium becomes liquid a little before the original specimen, and the liquid evaporates rather more slowly and lasts longer when both substances are compared under precisely similar circumstances. Nitrogen chemically prepared from nitric oxide was likewise changed by passing it over heated magnesium, for after this operation it liquefied and evaporated at a rather higher temperature than previously.

It would, therefore, appear that, whilst atmospheric nitrogen does experience change when passed over heated magnesium, some effect is also produced on chemically prepared nitrogen; and, as far as these experiments have been carried, they reveal no very marked difference between the behaviour of nitrogen from atmospheric air and nitrogen obtained from its compounds by chemical methods. It may be, however, that any concentrated impurity boils nearly at the same temperature as the original nitrogen, or that the amount present is so small that it does not liquefy at the temperature of −200° C. Considering that the flasks of 150 c.c. capacity contained the concentrated impurity of 10 litres of nitrogen, the partial pressure of small quantities of other matter ought to be very considerable, so that we might anticipate liquefaction at −200° C. At the lowest temperature reached atmospheric nitrogen which had been passed once over magnesium gave clear, transparent crystals along with liquid, while the untreated nitrogen remained fluid. All the samples of nitrogen and oxygen properly purified, when liquefied in the above manner, are clear, transparent liquids, so that the solid matter which always separates when air or nitrogen or oxygen is liquefied on the large scale consists of impurities. If a manometer is attached to the flask containing the gas, and at the same time the condensing tube is calibrated, the method of working gives quantitative results, since the pressure in the flask and the volume of liquid condensed can be simultaneously observed.

Further, if we use liquid oxygen as the cooling agent we can observe the vapour pressures of two or more substances at the same temperature, and these pressures may be expressed in terms of the vapour pressure of oxygen. In this way all very volatile liquids would be comparable with oxygen as a standard. If the vapour pressures of the substances are known with sufficient accuracy then the pressure in the flask which has been supplying the gas for liquefaction can be calculated. The following formulæ are sufficiently accurate, where N and O are respectively nitrogen and oxygen pressures in centimetres of mercury, and T absolute temperature.

$$\text{Log. } N = 9{\cdot}0762 - \frac{583{\cdot}8}{T},$$

$$\text{Log. } O = 8{\cdot}5681 - \frac{616{\cdot}8}{T},$$

therefore

$$\text{Log. } \frac{N}{O} = 0{\cdot}5081 + \frac{33}{T}.$$

According to the formulæ, if the oxygen bath is reduced to 2 cm. pressure, the pressure in the nitrogen flask is 17·8 cm., so that nearly three-fourths of the original mass of gas filling the flask appears in the liquid state. At the same time it must be understood that these experiments are merely qualitative, and were not carried out with the view of separating any new substance from air or nitrogen. Their chief object is to observe the points of condensation and evaporation of gases liquefying between −180° C. and −200° C. at and below atmospheric pressure.

Small amounts of known impurities cause marked differences in the amount of liquid formed from the same volume of gas similarly treated. Thus a trace of impurity, presumably hydrogen, in a sample of nitrogen subjected to liquefaction in the above manner only gave one-third the volume of liquid that a similar flask gave when filled with pure nitrogen. This is due to the concentration of the hydrogen or other non-liquefiable material in the narrow tube where liquefaction takes place.

This plan of working may be conveniently applied to testing whether the oxygen and nitrogen in air liquefy simultaneously. Such a question cannot be answered by liquefying air under pressure. If, however, two flasks such as have been described are taken, one filled with nitrogen at 0·79 of the atmospheric pressure, and the other with oxygen at 0·21 of the atmospheric pressure (the temperatures being equal), then on cooling them side by side the instant at which liquefaction takes place in the narrow condensing tubes can be observed. The oxygen always appears a few seconds before the nitrogen, and remains after the latter has evaporated. The boiling points of nitrogen and oxygen, under the respective pressures at which they exist in the atmosphere, are very close together.

Discussion.

The President, referring to experiments on the liquefaction of gases which he had recently witnessed in the Royal Institution Laboratory, said that the means of producing very low temperatures during long periods, now at Professor Dewar's disposal there, were marvellously complete and important results ought, before long, to flow from their application.

It was useless to deny that special interest attached to the communication to which they had just listened, but, unfortunately, in the absence of Lord Rayleigh and Professor Ramsay, they were left in the position of having to play "Hamlet" with only the ghost present, and, under such circumstances, the play obviously could not be continued to a successful issue. Chemists were deeply interested by the statements relating to the discovery of a new constituent of the atmosphere, brought before the British Association at Oxford, but they awaited further information before making up their minds. They were in a very different position, however, since Friday last, when the President of the Royal Society, in his address, referred to this discovery as the greatest scientific event of the year. It was to be supposed that the President of the Royal Society had information at his disposal, not hitherto made public, which justified so definite a statement and naturally chemists would impatiently await its disclosure. He ventured to say that Lord Rayleigh and Professor Ramsay now could not hope to keep so remarkable a discovery to themselves much longer. After having been told so much, chemists could not be expected to remain quiet under the imputation that they had been eyeless during a whole century, and they would undoubtedly enquire into the matter. Although no one would seek to take the discovery out of the hands of those who had announced it, chemists unquestionably had the right, not only to exercise entire freedom of judgment, but also to critically examine the statements which had been made. With regard to Professor Dewar's observations, which were such as could only be made with the aid of the low temperature appliances at his disposal at the Royal Institution, Professor Dewar would be the first to admit that they were of a qualitative character, and open to several interpretations; but they were certainly highly suggestive.

*75. "On the use of the globe in the study of crystallography."

By J. Y. Buchanan, F.R.S.

The author shows how a globe, on which figures and arcs can be drawn and measured, is serviceable in the study of crystallography exactly as the celestial and terrestrial globes are useful in the study of astronomy and geography. All the problems to which spherical trigonometry is usually applied can be readily solved by graphic constructions on the globe with an exactness which depends on the size of the globe and the refinement which has entered into its construction, and into that of the divided circles with which the measurements are made.

Mr. Bourne, with the aid of lantern slides, described a projective goniometer, independently designed and constructed on the same principle as that advocated by Mr. Buchanan, by Miss Edna Walter and himself, which was exhibited at the Royal Society's Soirée in June last.

A hollow metal sphere is supported on a horizontal axis, while the crystal to be measured is supported on a second axis parallel to and in the same vertical plane as the former. These two axes pass through the centres of two metallic discs of exactly the same circumference; the discs are geared together by two steel bands, so that they can rotate at the same speed without backlash, the sphere and crystal moving through the same angle. The discs are fixed to a heavy framework which can rotate about an imaginary vertical line, passing through the centre of the sphere and cutting the two supporting axes at right angles. By means of rotation about its two axes the crystal can be turned into any position whatever, and the sphere moves with exactly the same angular velocity. The two motions are controlled by two convenient handles. The usual arrangement of collimator and telescope is fixed in front of the crystal. A movable lens converts the telescope when required into a microscope, and the crystal can be rotated until any particular face is approximately perpendicular to the line bisecting the angle between collimator and microscope. The microscope lens is then removed, and the crystal is finally adjusted till an image of the signal attached with collimator is seen to intersect the lens wires in the telescope. In order that the best part of any face may be in the field of view, an adjustment allows telescope and collimator to move either vertically or horizontally parallel to the face. When the crystal face is thus in position a cross is printed on the sphere at such a spot that the radius of the sphere through the centre of the cross is parallel to a normal of the crystal face. Each face of the crystal is seen brought into the same position, and its pole marked upon the sphere. A complete projection is thus obtained, and the angles between the poles can be measured with a graduated arc. The accuracy with which this can be done depends, of course. upon the diameter of the sphere. In this particular instrument the diameter is 6 in., and it is possible to measure to within about 20 min. The working mechanism consists of a small india-rubber stamp, curved to fit the sphere, and having two fine intersecting raised curves upon it. It rests against a pad soaked with aniline dye and varnish, and moistened with alcohol; the latter rising through a slide from a tube below. On pressing a lever the stamp moves round a vertical axis, and presses against the sphere at the right spot.

*76. "A new method of obtaining dihydroxytartaric acid, and the use of this acid as a reagent for sodium." By H. J. H. Fenton, M.A.

In a former communication a new acid was described, which is obtained by oxidation of tartaric acid in presence of iron. The formula of this acid is $C_4H_4O_6$. It is dibasic, and crystallises with $2H_2O$. The molecule of this crystallised acid contains, therefore, two atoms of hydrogen more than that of dihydroxytartaric acid, and it is now shown that it readily yields the latter acid on oxidation. If bromine be employed as the oxidising agent, the change takes place quantitatively, according to the equation $C_4H_4O_6{\cdot}2H_2O + Br_2 = C_4H_6O_8 + 2HBr$. The solution so obtained gives a white, crystalline precipitate of the nearly insoluble sodium salt when neutralised with sodium carbonate. The yield of sodium salt does not fall far short of the theoretical.

From this salt the free acid is easily obtained by Miller's method (*Ber.*, 1889, 2015).

Since free dihydroxytartaric acid can be so readily obtained in this way, the author suggests its use as a reagent for the detection of sodium. The test is fairly delicate, and does not appear to be influenced by the presence of potassium or ammonium salts.

*77. "Essential oil of hops." By Alfred C. Chapman.

In a preliminary communication to the Society (Proc., 1893, 177) the author gave a brief account of a sesquiterpene prepared from the essential oil of hops by fractional distillation. Since then three other and much larger samples of the essential oil have been more fully examined with more definite results. All of these samples are of known origin and genuineness. The relative densities and specific rotatory powers having been determined, these samples of oil were submitted to fractional distillation under a pressure of 60 mm. of mercury, the fractions of corresponding boiling points being mixed after their identity had been ascertained.

After prolonged fractionation the following fractions were obtained. (1) 86—91°; (2) 145—150°; (3) 163—168°; (4) 168—173°.

Nos. 1 and 4 were the main fractions, the remaining two being small. Fraction No. 4 corresponded to nearly two-thirds of the oil used.

These fractions were then submitted to a careful investigation.

Fraction No. 1 was a colourless, mobile liquid, of characteristic smell. After purification by distillation over sodium under a pressure of 50 mm. it boiled at 86—89° at atmospheric pressure; b. p. 166—171°, rising afterwards to about 230° owing to polymerisation and oxidation. Its relative density at 20°/20° was 0·799, and it was optically inactive. On combustion it gave numbers closely agreeing with the formula $C_{10}H_{17}$; its vapour density also agreed with this formula. Hydrogen chloride was readily absorbed by this fraction, forming an oil which was, in all probability, a mixture of two distinct hydrochlorides.

Attempts to prepare a nitrosochloride, a nitrosate and a nitrosite from this fraction failed. It would appear to consist of two hydrocarbons, $C_{10}H_{16}$ and $C_{10}H_{18}$. The latter is probably tetrahydrocymene (b. p. 167°), whilst the former may be one of the "olefinic terpenes" described recently by Semmler. It is at least certain that the greater part, if not the whole, of the lower fraction consists of hydrocarbons other than the ordinary terpenes.

Fraction No. 2 (145—150°) occurred in such small quantities that its complete identification was not possible. It was a colourless oil having a pleasant smell of oil of geranium, with an after-smell of oil of rue. It did not solidify at $-10°$. Its relative density at 15°/15° was 0·885, and, on analysis, it gave numbers agreeing with those required for the formula $C_{10}H_{18}O$. It united readily with bromine, and in many of its properties appeared to bear some resemblance to geraniol.

Fraction No. 3 (163—168°) was a small fraction which was found to be a mixture of Fractions 2 and 4.

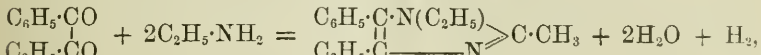
Fraction No. 4 (168—173°) was by far the largest. It consisted of a sesquiterpene, $C_{15}H_{24}$; the following are its chief properties. Boiling point, 263—266° (corr.); relative density at 15°/15° = 0·9001; molecular refraction 66·2, a sesquiterpene with two pairs of "doubly-linked" carbon atoms requiring 65·7; it was optically inactive, and unites with 4 atoms of bromine to form an oily bromide. The dihydrochloride could not be crystallised. With nitrosyl chloride it unites, forming a white, crystalline nitrosochloride melting at 164—165°. With piperidine this nitrosochloride reacts readily, forming a crystalline nitrol piperide melting at 153°.

This sesquiterpene is not identical with either cubebene (cadinene), caryophyllene, clovene, or cedrene, the only four sesquiterpenes of which we possess any definite knowledge, and it is therefore proposed to name it "humulene." In three out of the four samples of oil examined humulene was the main constituent.

78. "Interaction of 1 : 2-diketones with primary amines of the general formula $R'\cdot CH_2\cdot NH_2$. Second notice." By Francis R. Japp, F.R.S., and W. B. Davidson, M.A., B.Sc.

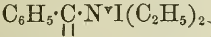
In a previous note on the interaction of benzylamine and benzil in presence of zinc chloride (Proc., 1894, 49), the authors showed that these substances yield tertiary and quaternary benzyl-derivatives of lophine. The present communication deals with results obtained in the study of analogous interactions.

Benzil and ethylamine interact according to the equation



$$\begin{array}{l}C_6H_5\cdot CO\\ \quad\;|\\ C_6H_5\cdot CO\end{array} + 2C_2H_5\cdot NH_2 = \begin{array}{l}C_6H_5\cdot C\cdot N(C_2H_5)\\ \qquad\;\;\|\\ C_6H_5\cdot C\text{———}N\end{array}\!\!\gg C\cdot CH_3 + 2H_2O + H_2,$$

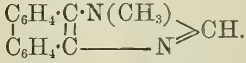
yielding *N-ethyl-diphenyl-μ-methyl-imidazole*, which forms lustrous prisms melting at 125·5°. When zinc chloride is present, a chloride of a quaternary base appears to be formed at the same time, as in the benzylamine interaction, but was not isolated in a state of purity. The constitution of the foregoing imidazole was proved by preparing it by the action of ethyl iodide on diphenyl-μ-methylimidazole. It also unites with ethyl iodide to form a quaternary iodide,



$$\begin{array}{l}C_6H_5\cdot C\cdot N^{v}I(C_2H_5)_2\\ \qquad\;\;\|\\ C_6H_5\cdot C\text{————}N\end{array}\!\!\gg C\cdot CH_3$$

(m. p. 163°).

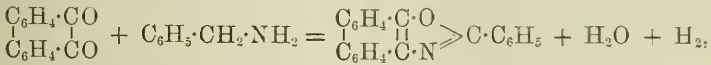
The action of methylamine on phenanthraquinone has been studied by Zincke and Hof (*Ber.*, **12**, 1644), who obtained a base to which they assigned the formula $C_{16}H_{14}N_2$. The present authors find, however, that the formula is $C_{16}H_{12}N_2$. The compound is formed in an interaction strictly analogous to that which occurs with benzyl and ethylamine, and its constitution is doubtless that of N-*methyl-diphenylene-imidazole*,



$$\begin{array}{l}C_6H_4\cdot C\cdot N(CH_3)\\ \;\;|\qquad\;\|\\ C_6H_4\cdot C\text{———}N\end{array}\!\!\gg CH.$$

The melting point was found at 188° (185—186°, Zincke and Hof).

Phenanthraquinone and benzylamine yield *diphenylene-μ-phenyloxazole*,



$$\begin{array}{l}C_6H_4\cdot CO\\ \;\;|\qquad\;|\\ C_6H_4\cdot CO\end{array} + C_6H_5\cdot CH_2\cdot NH_2 = \begin{array}{l}C_6H_4\cdot C\cdot O\\ \;\;|\qquad\;\|\\ C_6H_4\cdot C\cdot N\end{array}\!\!\gg C\cdot C_6H_5 + H_2O + H_2,$$

whilst, at the same time, a sparingly soluble compound of high melting point is formed, which appears to have the formula $C_{28}H_{17}NO$, but is difficult both to purify and to analyse.

79. "The isomeric dinitrodiazoamidobenzenes and their melting-points." By R. Meldola, F.R.S., and F. W. Streatfeild.

The authors have made a careful series of comparisons between their former preparations of diparadinitrodiazoamidobenzene and specimens placed at their disposal by Drs. Pawlewski and Bamberger. They find all three products to be identical, and have come to the conclusion that in this case there is no reason to suspect stereochemical isomerism in the sense advocated by Hantzsch. The discrepancies in the melting points given by different observers has been found to be due to the circumstance that the compound has no definite melting point, but a point of decomposition, as they had already stated in former papers. They have found that the pure compound can be made to melt at 220—236°, according to the rate at which the thermometer is raised. The hitherto unknown diorthocompound, $(o)NO_2{\cdot}C_6H_4{\cdot}N_3H{\cdot}C_6H_4{\cdot}NO_2(o)$, has been prepared, and consists of golden-yellow scales melting without decomposition at 196—196·5°. This compound has all the properties of a true diazoamide; it is acid in character, and forms salts which are somewhat unstable. The "protecting influence" of the nitro-group in the ortho-position renders the formation of alkyl ethers difficult, if not altogether impossible, and the authors have not yet succeeded in alkylating the compound.

80. "On the yellow colouring matter of 'Sophora japonica.'" By Edward Schunck, Ph.D., F.R.S.

The undeveloped flower-buds of *Sophora japonica*, a leguminous plant growing in the North of China, contain a yellow colouring matter which has been examined several times without any definite conclusion having been arrived at. Foerster, considering it as a peculiar substance, called it *sophorin*, but the author's experiments show that it is identical with rutin, the colouring matter of garden rue and other plants. It yields, on hydrolysis, quercetin and rhamnose. The numbers obtained by analysis corresponded with the formula $C_{27}H_{32}O_{16}$, in accordance with which its decomposition by hydrolysis would be represented by the following equation:

$$C_{27}H_{32}O_{16} + 3H_2O = C_{15}H_{10}O_7 + 2C_6H_{14}O_6.$$

Herzig's formula, $C_{15}H_{10}O_7$, was adopted as representing the composition of quercetin.

ADDITIONS TO THE LIBRARY.

I. *Donations.*

Year-Book of Pharmacy, comprising abstracts of papers relating to Pharmacy, Materia Medica, and Chemistry, contributed to British and Foreign Journals from July 1, 1893, to June 30, 1894, with the Transactions of the British Pharmaceutical Conference at the 31st Annual Meeting, held at Oxford, August, 1894. London 1894. Pp. 12 and 16—567. 8vo. From the Conference.

The Imperial University Calendar, 2553-54 (1893-94). Tokyo, 1894. 8vo. Pp. iii—265-12; with plans. From the University.

Roscoe-Schorlemmer's Kurzes Lehrbuch der Chemie nach den neuesten ansichten der Wissenschaft. Von Sir Henry E. Roscoe, LL.D., F.R.S., und Alexander Classen. Zehnte Vermehrte Auflage, mit 71 Holzstichen und einer Farbigen Spectraltafel. Braunschweig 1894. Pp. xxvi—541. 8vo. From the Author.

U.S. Geological Survey. J. W. Powell, Director. Geology of the Eureka District, Nevada, with an Atlas. By Arnold Hague. Washington, Government printing office, 1892. 4to. xvii+419 pp., 8 pl. Monograph XX. From the U.S. Geological Survey.

A Manual of Topographic Methods. By Henry Gannett, Chief Topographer. Washington, Government printing office, 1893. 4to. xiv+300 pp., 18 pl. Monograph XXII.

From the U.S. Geological Survey.

Thirteenth Annual Report of the United States Geological Survey to the Secretary of the Interior, 1891-92. By J. W. Powell, Director. Part I. Report of the Director. II. Geology; accompanying papers. III. Irrigation. Washington, Government printing office, 1893. 8vo. 3 v. From the U.S. Geological Survey.

A Dictionary of the Economic Products of India. By George Watt, M.B., C.M., F.L.S., Professor, Bengal Educational Department, on special duty with the Government of India, Department of Revenue and Agriculture, assisted by numerous contributors. Calcutta 1889. 8vo. In six (9) volumes. Vol. I, Abaca—Buxun. II, Cabbage—Cyperus. III, Dacrydium—Gordonia. IV, Gossypium—Linociera. V, Linum—Oyster. VI, 1, Pachyrhizus—Rye. VI, 2, Sabadilla—Silica. VI, 3, Silk—Tea. VI, 4, Tectona—Zypophyllum.

From the Secretary of State for India.

II. *By Purchase.*

Odorographia, a Natural History of Raw Materials and Drugs used in the Perfume Industry. Intended to serve Growers, Manufacturers, and Consumers. By T. Ch. Sawer, F.L.S. London 1892. Pp. xxiii.—383. 8vo.

Tabellarische übersicht der Naphtalinderivate. Auf Grundlage des Werkes: Sur la constitution de la Naphtaline et de ses Dérivés, par F. Reverdin et E. Noelting; unter Berücksichtigung der neueren Litteratur bearbeitet von F. Reverdin und H. Fulda. Erster Theil (Tabellen). Pp. viii.—36. Zweiter Theil (Litteratur). Pp. iv.—66. 4to. Basel 1893.

Versuch einer Kritik der Echtheit der Paracelsischen Schriften: Von Karl Sudhoff. Erster Theil: Die unter Hohenheim's Namen erschienenen Druckschriften (1527—1893). Pp. xiii.—722. Berlin 1894. 8vo.

Les Eaux Minérales de la France: Études Chimiques et Géologiques enterprises conformément au voeu Émis par l'Académie de Médecine sous les auspices du Comité Consultatif d'Hygiène Publique de France, par E. Jacquot et Prof. Willm. Pp. x (+ a page of errata) 602, and a map. Paris 1894.

Geschichte der Chemie von den ältesten Zeiten bis zur Gegenwart. Zugleich Einführung in das Studium der Chemie. Von Dr. Ernst von Meyer. Zweite, verbesserte und vermehrte Auflage. Pp. xiv.—522. Leipzig 1895. 8vo.

Die Wissenschaftlichen Grundlagen der Analytischen Chemie: Elementar dargestellt von W. Ostwald. Pp. viii.—187. Leipzig 1894. 8vo.

Organische Chemie von V. v. Richter. Siebente Auflage neu bearbeitet von Dr. R. Anschütz. Erster Band. Die Chemie von Fettkörper. Pp. xvi.—593. Bonn 1894.

Die Lagerung der Atome im Raume von J. H. Van't Hoff. Zweite umgearbeitete und vermehrte Auflage mit einem Vorwort von Dr. Johannes Wislicenus. Pp. xii.—147. Braunschweig 1894. 8vo.

Index of Spectra. By W. M. Watts, D.Sc., &c. Appendix B. Pp. 39. Manchester 1891. 8vo.

Appendix C. Pp. 104. Manchester 1892. 8vo.
Appendix D. Pp. 68. Manchester 1893. 8vo.
Appendix E. Pp. 54. Manchester 1894. 8vo.

Lehrbuch der Physiologischen und Pathologischen Chemie in fünfundzwanzig Vorlesungen für Ärzte und Studirende von G. Bunge. Dritte vermehrte und verbesserte Auflage. Pp. iv.—447. Leipzig 1894. 8vo.

Handbuch der Arzeimittellehre. Von Dr. H. Nothnagel und Dr. M. J. Rossbach. Siebente Auflage. Pp. xii.—932. Berlin 1894. 8vo.

Traité de la Fabrication du Sucre de Betterave et de Canne. Par

MM. L. Beaudet, H. Pellet, Ch. Saillard, et L. Raimbert. 2 tomes. T. I. Pp. xvi.—579. T. II. Pp. 703. Paris 1894.

L'Institut de Chimie Générale de l'Université de Liége. Par W. Spring. Pp. 2+80+12. Liége [1894]. 4to.

Wissenschaftliche Abhandlungen der Physikalisch-Technischen Reichsanstalt. Bd. I. Thermometrische Arbeiten betreffend die Herstellung und Untersuchung der Quecksilber-Normalthermometer unter Leitung und Mitwirkung. Von Prof. Dr. J. Pernet. Ausgeführt von Dr. W. Jaeger und Dr. E. Gumlich. Pp. xvi.—105, 439. Berlin 1894. 4to.

RESEARCH FUND.

A meeting of the Research Fund Committee will be held in January. Fellows who wish to obtain grants should send in written applications with full particulars to the Secretaries, at Burlington House not later than Thursday, January 10th.

At the next meeting, on Thursday, December 20th, the following papers will be read :—

"An improved form of barometer." By Dr. N. Collie.

"The chemical constituents of Piper Ovatum." By Professor Dunstan, F.R.S., and H. Garnett.

"Note on the active constituent of the Pellitory of medicine." By Professor Dunstan, F.R.S., and H. Garnett.

"The preparation of adipic acid." By Dr. W. H. Ince.

"Some derivatives of adipic acid." By Dr. W. H. Ince.

"The latent heat of fusion." By Holland Crompton.

"The conditions of reaction of hydrogen chloride with the alkaline earths." By V. H. Veley, M.A.

"Note on the interaction of bismuth haloid compounds and hydrogen sulphide." By M. M. Pattison Muir, M.A., and Edwin Eagles, B.A.

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Issued 11/1/1895

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

No. 145. Session 1894–95.

December 20th, 1894. Dr. Armstrong, President, in the Chair.

Messrs. Claude Smith and Frederick J. Allen were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Herbert Anderson, County School, Wellington, Somerset; Francis H. Carr, Meaburne, Warham Road, Croydon; Donald St. John Grant. M.A., M.B., Lahore, India; Herbert Grime, 11, Church Road, Chorlton-cum-Hardy, Manchester; John Adams Hatfield, 89, Bridge Street, Wednesbury; Percy Hudson, 48, Alexandra Road, Burton-on-Trent; Patrick Henry Kirkaldy, 68, East India Road, Poplar, E.; William Baxter McVey, 301, Saratoga Street, Boston, Mass.; Herbert Frederick Stephenson, 10, Muschamp Road, E. Dulwich, S.E.; Thomas C. Warington, 1, Charles Street, Hanley, Staffordshire; Henry Stow Young, 13, Balham Grove, S.W.

The following is the text of an address which has been sent to Professor C. Remigius Fresenius, who has now been fifty years a Foreign Member of the Society:—

"Geh. Hofrath Professor Dr. C. R. Fresenius,

"Dear Sir,

"It is little more than two years ago that the Chemical Society addressed its congratulations to Professor Bunsen, its senior Foreign Member, on the 50th anniversary of his election into our body. It is now our privilege, on behalf of the Fellows, to address you, who come next to him on our list of Foreign Members, on a similar occasion; and to congratulate you on having so long retained your vigour and pursued your career of usefulness in that most important branch of our science, analytical chemistry, the cultivation of which you have made so especially the work of your life.

"We rejoice to have your name among those of the early contributors to our journal, communications from you on an improved method for the detection and quantitative determination of arsenic, and on inorganic constituents of plants, appearing in the second volume of our Memoirs. Indeed, you were elected into our Society at a time when it was customary to choose as Foreign Members only those chemists abroad who had become directly and intimately connected with us by contributing to our Proceedings, your name coming very early on a list of such contributors at the head of which are the names of Liebig and Bunsen.

"There are still some among us who knew you as a student; not a few also who have been students under you; but you are also well known to the Fellows generally, all of whom, indeed, feel that they owe you much gratitude for the assistance that you have afforded them, both in their studies and in their professional work, through your invaluable text-books on qualitative and quantitative analysis, and through the 'Zeitschrift' you have so long conducted, which renders such signal service to chemists by keeping them informed of the progress of analytical chemistry.

"On behalf of English chemists generally, we have to express the earnest wish that you may be permitted during many years to come to continue to carry on labours which are so generally appreciated."

H. E. Armstrong, *President;* T. E. Thorpe, *Treasurer.*
J. M. Thomson, Wyndham R. Dunstan, *Secretaries.*
R. Meldola, *Foreign Secretary.*

Of the following papers those marked * were read.

*81. "An improved form of barometer." By J. Norman Collie, Ph.D.

In the improved form of barometer described by the author, several new devices are introduced. Lightness and strength are secured by using for the stem of the instrument thick Sprengel pump tubing. The upper and lower part of the barometer is made from the same piece of tubing, so that the diameter of the cisterns is the same throughout.

Just below the upper cistern a small glass trap is inserted, to prevent air which may creep up the stem from entering the Torricellian vacuum. The mercury in the lower cistern is connected with the upper part of the barometer by means of a small tube of capillary bore. This capillary tube is bent just below the point of junction with the bottom of the Sprengel tube, so as to lie along the inner wall of the lower cistern; by this means an unobstructed view of the top of the mercury at the lower level is obtained.

The scale may be etched either on the barometer itself or on a thick plate glass mirror, which is placed behind the instrument. Very accurate readings are thus obtained.

Mr. C. E. Müller has suggested a further improvement in the form of a ground-glass joint inserted in the middle of the barometer. This renders the instrument easier to fill and clean, besides allowing of its being packed in a box of convenient form.

*82. "The Constituents of Piper Ovatum." By Wyndham R. Dunstan, F.R.S., and Henry Garnett.

This is a West Indian medicinal plant growing in Trinidad. When chewed it gives rise to a tingling sensation and profuse salivation, accompanied by temporary local anæsthesia. The leaves were found to contain a terpene, and a considerable quantity of physiologically active resin, which is also present in the root and stems. From this "resin" the authors were ultimately able, by a tedious process, to separate a crystalline highly active substance, which they name *piperovatine*. Its composition is expressed by the formula $C_{16}H_{21}NO_2$, and it appears to possess an alkaloidal structure, but is, nevertheless, devoid of basic properties. It is nearly insoluble in water and in dilute acid and alkalis, but dissolves readily in alcohol, and the alcoholic solution exhibits the curious property of setting to a "jelly" of very minute crystals when water is added to it.

Piperovatine acts as a temporary depressant of both motor and sensory nerves, and also as a heart poison. It produces a powerful stimulant effect on the spinal cord, causing a tonic spasm resembling that of strychnine. It seems likely to be of service in therapeutics.

*83. "Note on the active constituent of the Pellitory of medicine." By Wyndham R. Dunstan, F.R.S., and Henry Garnett.

The similarity in the physiological effect produced by *Piper Ovatum* and by the Pellitory of medicine (*Anacyclus pyrethrum*), led the authors to examine this plant, the activity of which is usually ascribed to a resin. The authors have separated from this resin a crystalline, intensely active substance which they name *pellitorine*. In most of its chemical and physical properties it closely resembles piperovatine; but so far it has always exhibited certain small differences which may possibly disappear when the substance has been further purified. Both piperovatine and pellitorine appear to be pyridine derivatives, but neither possesses any appreciable basic power.

*84. "The determination of some high temperature freezing points by means of platinum-resistance pyrometers." By C. T. Heycock and F. H. Neville.

From time to time the authors have communicated to the Society the results of experiments on the freezing points of alloys in which sodium, tin, bismuth, cadmium, thallium, and lead were the solvent metals. These experiments have now been extended to temperatures above those in which a mercury thermometer could be used by means of a platinum-resistance pyrometer.

The results, recorded to the nearest whole number, are as follows.

	Freezing point.
Zinc	419° C.
Antimony	624 ,,
Magnesium	633 ,,
Aluminium	653 ,,
Silver	957 ,,
Copper	1081 ,,
Sodium carbonate	848 ,,
Sodium sulphate	883 ,,
Potassium sulphate	1066 ,,

In making an experiment the pyrometer is plunged into a mass of the molten substance well above its melting point, and the falling temperature is followed until it suddenly stops. This temperature is the *freezing point.* In the apparatus employed the temperature of freezing is maintained for a minute or more, and after this a fall is obtained which at first is very slow. If the pyrometer is now withdrawn it is found to have a very considerable quantity of solid substance adhering to it.

DISCUSSION.

Mr. GOWLAND called attention to the fact that the metals experimented on were not examined for impurities, although care had been taken to procure them as nearly pure as possible from manufacturers.

Zinc as met with in commerce always contains considerable amounts of lead. In some specimens only 0·4 per cent. is present, but in others as much as 1·9 per cent., and even more, is occasionally found. Zinc also contains cadmium, and this is especially the case in the so-called "pure" redistilled metal. Whilst investigating a method for the determination of antimony in copper by the nature of the fracture of one of its alloys with zinc, he had noticed that ordinary zinc (spelter) gave satisfactory results, but when so-called "pure" zinc which had been redistilled by the manufacturer was used, the results were altogether anomalous. On examining this zinc, it was found to be contaminated with cadmium, two cakes containing 5·1 per cent., another about 3 per cent., and a fourth little more than traces.

In the case of copper, commercial samples vary much in the proportions of metallic impurities and of suboxide present. Even electrotype copper is sometimes impure; copper should therefore always be tested, the simplest method being a determination of its electric conductivity, as this will generally sufficiently indicate the extent of its purity. Copper when melted, even under a thick layer of charcoal, will absorb oxygen, and become contaminated with suboxide.

He suggested that it would be desirable in future to ascertain the chief impurities in the metals experimented on, and to determine their amounts, for even when present in small proportions they often have, as is well known, marked effects on the physical properties. This would add very greatly to the value of the determinations of their freezing points, and would enable them to be compared with the results obtained by other observers.

*85. "The preparation of adipic acid and some of its derivatives."

By Walter H. Ince, Ph.D.

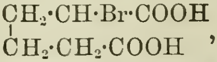
Wislicenus's method of preparing adipic acid by heating β-iodopropionic acid with silver being found to be unsatisfactory, other methods of preparation were investigated.

According to Arppe (*Zeit. f. Chem.*, 1865, 300), adipic acid may be readily prepared by the action of nitric acid on sebacic acid. The author finds, however, that not only has nitric acid no action on sebacic acid, but that sebacic acid crystallises unchanged from its solution in fuming nitric acid. By the action of potassium permanganate in neutral, acid, and alkaline solutions sebacic acid is entirely decomposed, yielding small quantities of a monobasic acid, but no adipic acid.

Malaguti (*Ann. Chim. Phys.*, [3], **16**, 84) states that when beef suet is heated with ordinary nitric acid, the main product is adipic acid. The author in repeating the experiment finds that when ordinary nitric acid is used, the main product consists of sebacic and azelaïc acids, and, when fuming nitric acid is used, an acid having the formula $C_{11}H_{20}O_4$ is among the products. In neither case could the presence of adipic acid be detected.

As might be anticipated, the action of nitric acid on beef suet is a complex one, and the products vary with the concentration of the acid employed: but in no case does adipic acid appear to be formed.

α-Monobromadipic acid,



$$\begin{array}{l} CH_2\cdot CH\cdot Br\cdot COOH \\ | \\ CH_2\cdot CH_2\cdot COOH \end{array}$$

, was prepared by Gal and Gay-Lussac (*Annalen*, **155**, 250), but was not obtained in a pure state. The author has isolated it in a state of purity by heating adipic acid (1 mol. prop.) with bromine (2 mol. props.) in a sealed tube at 160° for two hours. The semicrystalline contents of the tube are dissolved in ether, and yield on recrystallisation from absolute alcohol, small colourless crystals melting at 131°. When mixed with water or a dilute solution of potassium hydroxide, this acid readily changes into *α-hydroxyadipic acid*, $C_4H_7OH(COOH)_2$. This is extracted from the aqueous solution by ether, which on evaporation deposits colourless crystals melting at 151°, and subliming without decomposition. This acid is soluble in alcohol, water, and ether.

*86. "The action of hydrogen chloride on the oxides of calcium, barium, and magnesium." By V. H. Veley, F.R.S.

In continuation of former experiments (Trans., 1893 and 1894), the author finds that dry hydrogen chloride does not act on quicklime at ordinary temperatures, or at 40°, but at 80° action occurs. Dry hydrogen chloride does not act on magnesia at ordinary temperatures; at 40°, however, action takes place to a considerable extent. Dry hydrogen chloride was observed to attack baryta at all temperatures.

DISCUSSION.

The PRESIDENT expressed the opinion that our knowledge of the conditions which determine chemical change, and of the influence of water, was now such that it was necessary to adopt every possible precaution in preparing dry materials, and that the mere passage of a gas *over* a drying agent was not sufficient. He thought that on this account Mr. Veley's results were entirely inconclusive, and that the enquiry ought to have been carried further before an attempt was made to state conclusions. It was to be expected that barium oxide would be more easily acted on, as baryta was dehydrated less readily than lime or magnesia.

*87. "Latent heat of fusion." By Holland Crompton.

If the latent heat of fusion of a unit weight of a metal is multiplied by the atomic weight of the element and divided by the absolute temperature of fusion, the resulting quantity is proportional to the valency of the metal, or in other words equivalent quantities of the metallic elements undergo on fusion equal changes in entropy. In modified form this rule is found to hold also for the non-metals.

In the case of compounds, the molecular latent heat of fusion divided by the absolute temperature of fusion is also proportional to the sum of the valencies of the atoms composing the molecule. It is necessary, however, in this case to suppose that the valencies are to a certain extent influenced by the mode of union of the atoms with one another, and modified in accordance with certain definite empirical rules stated by the author.

For elements, therefore, the relationship $wA/Tv = 1{\cdot}38$, and for compounds the similar relationship $wM/T\Sigma v = 1{\cdot}38$ is found to hold.

w is the latent heat of unit weight, A the atomic and M the molecular weight, T is the absolute temperature of fusion, and v and Σv are the valencies and the sum of the valencies respectively.

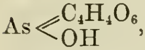
By combining these expressions with van't Hoff's formula for the molecular depression of the fusing point, $E = 0{\cdot}02T^2/w$, it is possible to calculate the molecular depression from the values of v and T. The numbers thus calculated are compared with those obtained by direct measurement and found to be in fair agreement. Solubilities or the melting points of mixtures of known composition can also be calculated, making use of the formula given by Schröder (*Zeit. physikal. Chem.*, **11**, 449), connecting the solubility with the latent heat of fusion and melting point in absolute temperature. Here, again, agreement between the calculated and observed values is obtained.

The relationship enunciated in the paper throws a new light on the question of the mechanism of the change from the solid to the liquid condition. It indicates that this change is one in which the simple chemical molecules and the atoms composing them are mainly concerned, and that it does not consist merely in the transition of complicated to simpler molecular aggregates.

88. "Metallic tartrarsenites." By G. G. Henderson, D.Sc., M.A., and A. R. Ewing, Ph.D.

Arsenious oxide dissolves readily in hot solutions of sodium hydrogen tartrate, and when the liquid is concentrated and cooled, colourless, prismatic crystals of *sodium tartrarsenite*, $C_4H_4O_6AsONa{\cdot}2\frac{1}{2}H_2O$, separate. This is a stable salt, easily soluble in water, but insoluble in alcohol. The aqueous solution has an acid reaction, and when neutralised with soda gives a mixture of arsenious oxide and disodium tartrate. The corresponding *ammonium* salt resembles the sodium salt, but is more unstable, gradually decomposing, even in the solid state, into arsenious oxide and ammonium hydrogen tartrate. *Potassium tartrarsenite* is at once decomposed by cold water, and hence is prepared with greater difficulty. It is obtained as a finely crystalline precipitate. The characteristic *barium* salt, $(C_4H_4O_6AsO)_2Ba{\cdot}H_2O$, is prepared in the form of delicate lustrous needles by mixing dilute solutions of barium chloride and of the sodium salt. It is only slightly soluble in hot water, and is partially decomposed when boiled with much water, like all the salts of the series hitherto examined. The *strontium* and *calcium* salts are more soluble, and much less stable in solution. The heavy metals give precipitates with soluble tartrarsenites, but these precipitates appear to be in most cases either tartrates or mixtures of tartrates with arsenious oxide.

When the barium salt is cautiously mixed with dilute sulphuric acid, keeping the salt in excess, a clear filtrate is obtained, which has a strong acid reaction, but contains no sulphuric acid, and which gives a copious precipitate of arsenious sulphide when hydrogen sulphide is added. The solution probably contains free tartrarsenious acid, $C_4H_4O_6AsOH$, but this is too unstable to be isolated. Concentration of the solution, or raising its temperature to 60—70°, or addition of alcohol or of a trace of a mineral acid, causes decomposition of the acid into arsenious oxide and tartaric acid; but if soda is added, sodium tartrarsenite is formed, and a quantitative examination of the solution proved it to contain almost exactly the theoretical quantity of arsenic.

Experiments with other acid oxides and hydoxy-acids indicate that tartrarsenious acid is either a derivative of arsenious acid,  $As\genfrac{}{}{0pt}{}{<C_4H_4O_6}{<OH}$, or an ethereal derivative of tartaric acid, having the formula $CO_2H\cdot CHO(AsO)\cdot CHOH\cdot CO_2H$.

89. "Note on the interaction of hydrogen sulphide and bismuth haloid compounds." By M. M. Pattison Muir, M.A., and Edwin M. Eagles, B.A.

The authors find that bismuth chloride and hydrogen sulphide react at a very moderate temperature, producing bismuth thiochloride, BiSCl, and hydrogen chloride; that a similar action occurs between bismuth bromide and hydrogen sulphide; but that bismuth iodide and hydrogen sulphide do not interact. They also prove that bismuth sulphide is produced by the interaction of bismuth chloride, or bromide and hydrogen sulphide at a red heat. The thiohaloid compounds BiSCl and BiSBr are also formed very readily by passing chlorine or bromine vapour over bismuth sulphide. Bismuth thioiodide was obtained, but not quite free from bismuth sulphide, by heating bismuth sulphide with bismuth iodide.

Erratum in "Proceedings," No. 144, p. 226. Between lines 11 and 12 insert "Discussion."

At the next meeting, on Thursday, January 17th, the following papers will be read:—

"Acid sulphate of hydroxylamine." By Dr. Divers, F.R.S.

"Mercury and bismuth hypophosphites." By S. Hada.

"Kamala." Part III. By A. G. Perkin.

Harrison and Sons, Printers in Ordinary to Her Majesty, St. Martin's Lane.

A LIST

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OF

THE CHEMICAL SOCIETY.

CORRECTED TO APRIL, 1894.

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HARRISON & SONS, ST. MARTIN'S LANE,
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1894.

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‖ Denotes Life Members.
Trans. Denotes Members who have contributed Papers published in the Society's Transactions.
Proc. ,, ,, ,, ,, ,, ,, ,, ,, Proceedings.

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Dec. 21, 1871	Trans.	Abney, W. de W., Capt., R.E., F.R.S., F.R.A.S., F.R.G.S., Willeslie House, Wetherby-place, South Kensington, S.W.
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Feb. 18, 1892		Adams, Frederick Edward, M.D., Town Hall, Bolton
Feb. 15, 1877	Trans.	‖Adams, M. A., F.R.C.S., Ashford-road, Maidstone, Kent
June 16, 1892		Adams, Percy T., Kent County Ophthalmic Hospital, Maidstone
Dec. 15, 1892		Adcock, Lionel Robert, Laboratories Rio Tinto Minas, Huelva, Spain
Dec. 5, 1889	Trans.	Addyman, F. Thornton, 53, Bentinck-road, Nottingham
Mar. 17, 1881	Trans.	Adeney, W. E., Royal University of Ireland, Earlsfort-terrace, Dublin
Dec. 3, 1885	Trans.	Adie, R. Haliburton, M.A., 3, Richmond-road, Huntingdon-road, Cambridge
Dec. 3, 1885		Adriance, John S., 231, Broadway, New York City
Dec. 3, 1885		Aikman, Charles M., M.A. B.Sc., F.R.S.E., F.I.C., Technical College, and 128, Wellington-street, Glasgow
Mar. 6, 1873		Ainsworth, George, Selby Lodge, Consett, Durham
Dec. 18, 1879		Albright, G. Stacey, The Elms, Edgbaston-park-road, Edgbaston, Birmingham
Feb. 16, 1893		Albuquerque, John Predozod, de Barbados, West Indies
May 7, 1885		Alcock, Frank Harris, 9, Broad-street Corner, Birmingham
June 16, 1892		Alcock, John W., Central Brewery, 45, Mott-street, Birmingham
June 21, 1888		Alexander, John, M.A., Avon Villa, Craigie, Perth

Date of Election.		
Feb. 16, 1882		Alford, Henry James, M.D., 1, Hovelands-terrace, Taunton
Mar. 4, 1886		Allan, James Henry, 26, Fitzclarence-street, Liverpool
Feb. 18, 1864	Trans.	Allen, Alfred Henry, Sydenham-cottage, Park-lane, Sheffield
Dec. 3, 1891		Allen, George James, Ivey House, Bolton-road, Pendleton
May 5, 1870		Allen, John, Phœnix Chemical Works, Upper North-street Poplar, E.
Feb. 3, 1876		Allen, Harry, Bessemer Steel Works, Sheffield
Feb. 6, 1890		Allsom, Edward W., L.R.C.P., L.R.C.S., C.M.Ed., C.F.P.S.Glas., L.A.H.D., and P.S.I., 41, South Mall, Cork
Mar. 5, 1885	Trans.	‖Amphlett, Edward Greenhill, M.A., Oxon, M.R.I., 2, Queen's Gate-terrace, S.W.
Mar. 6, 1890		Anderson, Frederic Alfred, B.Sc., Lesney House, Erith, Kent
Feb. 6, 1890		‖Anderson, Innes M. T., The New Explosives Company, Stowmarket
Dec. 15, 1892		Anderson, William Smellie, Marine Station, Granton.
eb. 2, 1888		Andrews, Edward Arthur, St. Mary's Hospital, Paddington, W.
May 4, 1882		Andrews, L. W., Ph.D., The University, Iowa City, Iowa, U.S.A.
Mar. 7, 1870		Andrews, Thomas, F.R.S., M.I.C.E., Ravencrag, Wortley, near Sheffield
Feb. 15, 1877		Angell, John, 6, Beacon's Field, Derby-road, Fallowfield, Manchester
Feb. 17, 1876		Ansdell, Gerrard, 10, Gledhow Gardens, South Kensington, S.W.
Feb. 6, 1890		Ansell, Frederick Graham, Wickwar Brewery, Gloucestershire
June 19, 1879		Appleby, Herbert, Moorfield Chemical Works, Boothstown, near Manchester
Feb. 19, 1891		Appleton, Henry Austin, c/o Dr. Hess, Oil Works, Newlay, near Leeds
May 15, 1890		Appleyard, James Robert, University College, Dundee
Feb. 21, 1884		Archbutt, Leonard, 11, Charnwood-street, Derby
Feb. 4, 1875		Armistead, William, M.B., C.M., Shelford, Cambridge
Dec. 15, 1881		Armitage, Charles, Lancaster Corporation Gas Works, Lancaster
Dec. 1, 1870	Trans.	Armstrong, Henry E., Ph.D., F.R.S., 55, Granville Park, Lewisham, S.E. and Central Institution, Exhibition-road, London, S.W.
Dec. 2, 1880		Arnold, J. Oliver, The Technical School, St. George's-square, Sheffield
Dec. 3, 1891		Ashcroft, George Alfred, c/o Mrs. Foster, 6, Winnington-street, Northwich, Cheshire
Dec. 18, 1884		Ashe, William Percy, M.D., 41, Sloane-gardens, S.W.
Dec. 15, 1870		Ashwell, J. R., F.I.C., 27, Tennyson-street, Nottingham
Mar. 17, 1859	Trans.	‖Atkinson, E., Ph.D., Portesbery-hill, Camberley, Surrey
Mar. 7, 1872	Trans.	‖Atkinson, R. W., B.Sc., 44, Loudoun-square, Bute Docks, Cardiff
Jan. 16, 1862	Trans.	‖Attfield, Prof. J., F.R.S., 17, Bloomsbury-square, W.C. and Ashlands, Watford

Date of Election.		
Feb. 18, 1872	Trans.	‖Attwood, George, F.G.S., Assoc. Member Inst. C.E., Durmast House, Ringwood, Hants, and 18, St. Swithin's-lane, Cannon-street, E.C.
Dec. 2, 1886		Audley, James A., B.Sc. Lond, A.R.C.Sc. Lond, F.I.C., 97, Lichfield-street, Hanley
Nov. 6, 1876	Trans.	Auerbach, G., Mannheim L., 7, 4, Germany
Feb. 17, 1877		Austen, Peter Townsend, 876, President-street, Brooklyn, New York
Dec. 15, 1892		Avery, David, Queen's College, University of Melbourne
Feb. 19, 1891		Aylan, John Charles, Manager Royal Laboratory, Royal Arsenal, Woolwich, S.E.
Mar. 6, 1890		Babington, Percival, A.I.C., 6, Grange-terrace, Weymouth
Dec. 16, 1875	Trans.	Bailey, G. H., Ph.D., D.Sc., Owens College, Manchester
June 15, 1893		Bailey, Henry, 18, Lavender Sweep, S.W.
April 4, 1889		Bailey, Richard Douglas, City Brewery, Quay-street, Gloucester
Feb. 21, 1884		‖Bain, Daniel, Laboratory, Newcastle Chemical Company, Gateshead
May 4, 1893		Baine, Lawrence Augustus, Dipton, Linlz-green, Newcastle-upon-Tyne
Dec. 3, 1891		Bairstow, John, 32, Sealand-road, Chester
Dec. 5, 1889		‖Baker, Charles Frederic, Ph.D., The Yorkshire College, Leeds
Dec. 6, 1883		Baker, Charles J., The Schools, Shrewsbury
Feb. 17, 1881	Trans.	Baker, Harry, The Aluminium Co., Oldbury, near Birmingham
June 19, 1884	Trans.	‖Baker, H. Brereton, Dulwich College, S.E.
May 4, 1893		Baker, Julian L. Stamford, Hendham-road, Upper Tooting, S.W.
May 1, 1873		Baldock, John Henry, Overdale, St. Leonard's-road, Croydon, Surrey
June 16, 1892		Ballantyne, Horatio, 260, Renfrew-street, Glasgow
Dec. 18, 1884		Ballard, J. Farrow, Cornwall House, Maidenhead
Dec. 3, 1891		Baly, Edward C. Cyril, Ardmore, Ritherdon-road, Tooting, S.W
Mar. 4, 1886		Bamber, Henry K. G., Cement Works, Dovercourt, Essex
Dec. 4, 1890		Bamber, M. Kelway, c/o Post-office, Poona, India
Feb. 15, 1894		Bamber, William Edward, Spring Lawn, Heaton, near Bolton
Feb. 2, 1888		Banner, Samuel, Sherwood, Sefton-park, Liverpool
Jan. 19, 1871		Bannister, Richard, Inland Revenue Laboratory, Somerset House, W.C.
Feb. 16, 1888		Barbour, T. Fraser, 35, Robertson-street, Glasgow
Dec. 2, 1880		Barclay, Arthur E., 95, Farringdon-street, E.C.
June 16, 1887		Barclay, Hugh, Calder Avenue, near Coattridge, N.B.
Dec. 1, 1870		Barklie, Robert, Thornhill, Dunmurry, Belfast
Jan. 17, 1889		Barnes, Charles Lightfoot, 10, Nelson-street, C. on M., Manchester
May 7, 1891		Barnes, Edward Arthur, Upton Villa, Dynamite Works, Hayle, Cornwall

Date of Election.		
Dec. 2, 1875		‖Barnes, R. L., Oak Hall, Buckhurst-hill
Feb. 21, 1884		Barr, William Henry, M.D., Belgrave-place, Bury
Feb. 16, 1888		Barraclough, William H., F.I.C., 83, Bedford-row, Ilford
May 5, 1892		Barratt, Alexander, Bronhenlog, Mostyn, North Wales
Dec. 3, 1891		Barratt, J. Treeby, Bronhenlog, Mostyn, North Wales
Feb. 4, 1869		Barret, Edward L., B.Sc., 192, Belsize-road, Hampstead, N.W.
Feb. 5, 1874		Barrett, Howard, M.R.C.S., M.R.C.P., 49, Gordon-square, W.C.
June 16, 1892		‖Barrows, Arthur Edward, Bloomfield Iron Works, Tipton, Staffordshire
April 4, 1889		Barry, T. D. Collis, M.R.C.S., Staff Surgeon, Malabar-hill, Bombay
Jan. 18, 1872		Barton, Robert, Royal Mint, Melbourne, Australia, and c/o Miss Barton, The Cottage, Bushey Park, Teddington
April 19, 1883		Basker, J. A., Fore-street, Bridgwater
Feb. 18, 1864	Trans.	‖Bassett, Henry, 26, Belitha-villas, Barnsbury, N.
May 7, 1891		Bate, William, National Explosives Co., Hayle, Cornwall
June 15, 1893		Bateman, John, Messrs. J. C. and J. Field, The Marsh, Lambeth, S.E.
May 7, 1891		Bater, Claude H., M.A., Inland Revenue Laboratory, Ashwell, Baldock, Herts
June 16, 1892		Bayliss, Charles, Selly Park, near Birmingham
Nov. 19, 1874		Bayly, F. W., The Royal Mint, E.
June 4, 1874		‖Bayne, James, Professor Royal Veterinary College, Camden Town, N.W.
June 19, 1879		‖Bayne, William Thirlwall, LL.D., Brockhill, Broad Clyst, Exeter
Dec. 4, 1873		Baynes, James, jun., Ph.D., F.R.M.S., Borough Analyst's Office, Royal Chambers, Scale-lane, Hull
Feb. 19, 1891		Beadle, Clayton, Beadonwell, Belvidere, Kent
Feb. 7, 1861		‖Beadnell, Major Charles Edward, R.A., 48, Castletown-road, W. Kensington
Dec. 5, 1867		Beale, William Phipson, Q.C., 10, New-court, Carey-street, Lincoln's-inn, W.C.; and 19, Upper Phillimore-gardens, Kensington, W.
Mar. 3, 1864		‖Beanes, Edward, Moatlands, Paddock-wood, Kent
Mar. 6, 1890		Beardmore, G. Russell, D.P.H. Camb., L.R.C.P. Lond., M.R.C.S. Eng., L.S.A., Warwick House, Upper-street, Islington, N.
April 21, 1887		Beasley, William C. T., B.A., Fermain, St. Leonards-on-Sea
Dec. 1, 1864		‖Beauchamp, Lient. C. S., Brompton Barracks, Chatham
April 17, 1890		Beck, Charles R., 6, White Ladies'-road, Clifton, Bristol
April 2, 1874	Trans.	Beckett, George Henry, care of Alfred Nobel, Chemisches Laboratorium, San Remo, Italy
May 4, 1882		Beckett, John Hampden, Corbar Hill House, Buxton, Derbyshire
Feb. 6, 1879	Trans.	Bedson, P. Phillips, D.Sc., University of Durham, College of Physical Science, Newcastle-on-Tyne

Date of Election.		
Dec. 19, 1872	Trans.	‖Beilby, George T., St. Kitts, Slateford, N.B.
June 18, 1891		Belbin, T. St. John, 12, Bolton-gardens West, South Kensington
Dec. 6, 1888		Belcher, John Hope, B.A., Science School, Lincoln
May 7, 1891		Bell, Albert Edward, Hound-street, Sherborne, Dorset
Dec. 2, 1886	Trans.	Bell, Chichester A., B.A., M.B. (Dublin), 3, Mansfield-place, Richmond, Surrey
June 20, 1889		Bell, E. Wightman, Spalding
Jan 19, 1865		‖Bell, J. Carter, the Cliff, Higher Broughton, Manchester
Dec. 3, 1863	Trans.	Bell, Sir Lowthian, Bart., F.R.S., Rounton Grange, Northallerton
Jan. 17, 1889		‖Bell, Percy Carter, Technical Laboratory, 13, Park-row, New York
Nov. 19, 1885		Bell, W. J., Sir, LL.D. (Cantab), F.R.S.E., Scatwell, Muir of Ord, N.B., and Reform Club, S.W.
Dec. 4, 1879		Bemrose, Joseph, 56, St. Famille street, Montreal, Canada
Dec. 17, 1874		‖Bendix, David, Sutherland Lodge, 371, Romford-road, Stratford, E.
Nov. 19, 1874		Benger, Frederick Baden, F.I.C., The Grange, Knutsford, Cheshire
Feb. 17, 1881		‖Benjamin, Marcus, A.M., Ph.D., care of D. Appleton and Co., 1, Bond-street, New York
April 15, 1886		Bennert, Carl, Ph.D., Godesberg, Germany
Dec. 4, 1890		Bentz, Ernest, 147, Bishop-street, Alexandra Park, Manchester
June 21, 1883		‖Beringer, Cornelius, F.I.C., 9, West-end, Redruth
Feb. 16, 1882		‖Beringer, John J., Basset-road, Camborne, Cornwall
Mar. 6, 1890		Berncastel, Richard, 7, Lancaster-road, Bayswater, W.
June 17, 1875		Bernstein, Ludwik, M.D., F.R.S.E., Lismore, New South Wales
June 15, 1893		Berridge, Douglas J. C., B.A. Oxon, The Laboratory, Malvern College
Feb. 16, 1888		Berridge, Henry Dudley, M.A., Fotheringhay, Oundle, Northamptonshire
Dec. 7, 1882		‖Berry, Edward E., Villa Rosa, Bordigherd, Italy
Dec. 3, 1891		Berry, Thomas William, 7, Tanley-street, Stone, Staffordshire
Dec. 6, 1888		Berry, William, 7, Hampton-park, Redland, Bristol
Dec. 15, 1892		Bersusan, Arthur J., 13, Lansdowne-road, Kensington-park, W., and Box 411, G.P.O., Sydney, N.S.W.
Mar. 1, 1883	Trans.	Bevan, Edward J., 4, New-court, Lincoln's-inn, W.C.
Dec. 2, 1886		Bevan, John William, care of Sir James Murray and Co., Chemical Works, Temple-street, Dublin
Dec. 7, 1865		‖Bickerdike, W. E., Clayton Grange, Wilpshire, near Blackburn
Feb. 18, 1875		Biggart, J. W., Chemical Laboratory, 29, Cathcart-street, Greenock
Mar. 7, 1872		Biggs, C. H. W., 140, Salisbury-court, Fleet-street, E.C., and Broomfield, Bromley, Kent
Mar. 16, 1882		Billing, Henry S., c/o Burnard & Alger, Ld., Plymouth

Date of Election.		
Dec. 15, 1881		Bingley, John, Northampton
June 4, 1874		Bird, Henry, 10, Lockyer-road, Mutley, Plymouth
Feb. 15, 1894		Bird, William Rowland, 73, Albion-street, New Swindon, Wilts
May 20, 1875	Trans.	Bischof, Gustav, Prof., 16, Colville-square, Bayswater, W., and 4, Hart-street, Bloomsbury
April 17, 1879		Black, A. H., F.R.G.S., St. John's, Wakefield
Dec. 2, 1886		Blackburn, Thomas, Aruba Phosphaat Maatschappy, Curaçoa, West Indies
Dec. 18, 1879		Blackett, Cuthbert R., Prof., Laboratory, Swanston-street, Old County Court, Melbourne
March 5, 1885		Blades, Chas. Mountain, Bay Villa, Chester-road, Northwich, Cheshire
Dec. 6, 1883		Blair, Frank A., Broomfield, Melrose, N.B.
Mar. 6, 1890		Blake, Robert R. F., Chemical Department, Queen's College, Belfast
May 15, 1890		Blake, William Henry, 7, Grange-crescent, Sunderland
June 3, 1875		||Blanshard, Charles Thomas, M.A., F.I.C., The Firs, Summertown, Oxford
June 16, 1892		Bleckly, Arthur Sanderson, Thelwall Lea, near Warrington
Dec. 4, 1890		Blenkinsop, W. E. B., 15, Earlsfield-road, Wandsworth Common, S.W.
Feb. 19, 1891		Bloomer, Frederick John, F.I.C., Bacchus-road, Lodge-road, Hockley, Birmingham, and 15, Broderick-road, Upper Tooting
Mar. 6, 1890		Blount, Bertram, Laboratory, Broadway, Westminster, S.W.
Feb. 2, 1888		Bloxam, Arthur G., F.I.C., The Goldsmiths' Institute, New Cross, S.E.
Dec. 20, 1883	Trans.	Bloxam, W. Popplewell, B.Sc. Lond., F.I.C., Royal Naval College, Greenwich, S.E.
Feb. 2, 1865	Trans.	Blunt, T. P., M.A., Tower-place, Shrewsbury
April 21, 1887		Blundstone, Edwin Richardson, B.A., Cornwall Lodge, Hampton Hill, Middlesex
June 3, 1875	Trans.	Blyth, Alexander Wynter, M.R.C.S., 17, Marlborough Hill, N.W.
May 5, 1892		Blyth, Frederic William George, Clifton Wood Villa, Clifton, Bristol
May 5, 1892		Blyth, M. Wynter, Junr., 8, New-court, St. John's College, Cambridge.
Dec. 2, 1875		||Boake, A., Stratford, London, E.
Mar. 1, 1883		||Board, Gregory, c/o Whitham Cross, Secretary Colorado Scientific Society, Box 2658, Denver, Colorado
Feb. 7, 1878		Bodmer, Richard, Analytical Laboratory, 16, Southwark-street, London, S.E.
Dec. 6, 1888		Bohm, William Dunsmore, A.R.S.M., F.I.C., 51, The Avenue, Acton, W.

Date of Election.		
Mar. 18, 1869	Trans.	‖Bolas, Thomas, Turnham-green, W.
Feb. 18, 1892		Bond, Frederick Fielding, M.D., Rosemary House, Rastrick, Yorks
June 17, 1858		Bond, F. T., M.D., Gloucester
Feb. 1, 1883		Bond, Henry C., M.A., Bromley Park School, Bromley, Kent
May 4, 1893		Bone, William Arthur, Owen's College, Manchester
Feb. 16, 1893		Boone, W. T., 6, Mount Pleasant-road, South Tottenham, N.
Mar. 1, 1877		Borland, John, F.L.S., Etruria, Kilmarnock
April 17, 1884		Borland, W. D., Beacon Lodge, Green-street, Green, near Dartford, Kent
Mar. 17, 1881		‖Borns, Henry, Ph.D., 19, Alexandra-road, Wimbledon, S.W.
Feb. 2, 1861		‖Bosanquet, R. H. M., F.R.S., New University Club, St. James'-street, S.W.
June 16, 1881		Bostock, G. H., Laurel Villa, Hildersthorpe, Birdlington Quay
Dec. 15, 1881	Trans.	Bothamley, Charles H., F.I.C., Taunton, Somerset
June 16, 1887	Trans.	Bott, William, Ph.D., Raffles Institution, Singapore
Mar. 6, 1873		Bottle, Alexander, 4, Godwyn-road, Dover
June 15, 1871		Bottomley, James, B.A., D.Sc., Homer-terrace, 220, Lower Broughton-road, Manchester
May 15, 1869		Bottomley, James T., M.A., F.R.S., F.R.S.E., 13, University Gardens, Glasgow
Dec. 2, 1886		Bottomley, W. Beecroft, Ph.D., 15, Lillyville-road, Fulham, S.W.
Feb. 15, 1894		Boul, William Good, M.A., The College, Petersfield
Dec. 3, 1891		Bovell, John R., Dodd's Botanical and Experimental Station, Barbados
April 20, 1865		‖Bowdler, A. C., 20, Wellington-street, Blackburn
Dec. 6, 1888		Bower, Frank, 37, Lansdowne-road, South Lambeth-road, S.W.
Dec. 7, 1893		Bowman, Frederic Edmund, Ash Leigh, Bowdown, Cheshire
Nov. 6, 1862		Bowman, Frederick H., F.R.A.S., F.L.S., F.G.S., Ashleigh, Ashley Heath, Bowdon, Cheshire
Dec. 16, 1869	Trans.	Bowrey, J. J., Kingston, Jamaica
April 15, 1869		‖Braby, Frederic, Bushey Lodge, Teddington
June 21, 1888		Bradshaw, Charles, 10, The Nook, Barber-road, Sheffield
Mar. 2, 1876		‖Bradley, Nathaniel, Sunnyside, Whalley Range, Manchester
Mar. 17, 1881		Braga, J. F., L.S.A., F.R.G.S., Glen Villa, Halliford-road, Sunbury-on-Thames
Nov. 20, 1890		Branson, Charles F., Frankfort House, West-side, Clapham Common, S.W.
Dec. 7, 1882		Branson, F. W., 14, Commercial-street, Leeds
June 15, 1882	Trans.	Brauner, B., Ph.D., University of Prague, Bohemia, and Brenute Gasse, 4, Prague, Bohemia

Date of Election.		
Dec. 6, 1883		Briant, Lawrence, 24, Holborn-viaduct, E.C.
Dec. 4, 1890		Brierley, John Thomas, 96, Bolton-road, Chorley, Lancashire
Dec. 7, 1893		Briggs, Harry Fielding, Tower House, White Ladies'-road, Clifton, Bristol
May 4, 1893		Briggs, John Frederick, c/o Messrs. Parry and Co., South Arcot, Nellikuppani, Madras Presidency
April 19, 1883		Briggs, T. Lynton, 357, Madison-street, Brooklyn, New York, U.S.A.
Dec. 18, 1884		‖Briggs, William, Burlington House, Cambridge
Feb. 6, 1890		Brindley, George F., Aluminium Company, Oldbury, near Birmingham
April 4, 1889		Broadbent, Harry, A.I.C., 125, Belle Vue-road, Leeds
Feb. 6, 1879		‖Broadbent, John J., Ellesmere House, Patricroft, near Manchester
Feb. 1, 1883		Brock, John, J.P., 17, Abercromby-square, Liverpool
Feb. 16, 1893		‖Brockbank, John Edwin, The Croft, Kirksanton, viâ Carnforth
Dec. 18, 1884		Brodie, Sir Benjamin V. S., Bart., Brockham Warren, Betchworth
Feb. 16, 1893		Brooke, Edward, West-court, Chalk, Gravesend, Kent
Dec. 16, 1886		‖Brothers, Horace Edward, Zaffre Cottage, Golden Hill, Stoke-on-Trent
Jan. 17, 1884		Brough, Bennett Hooper, Assoc. R.S.M., F.I.C., F.G.S., Grove Lodge, Thames Ditton
Nov. 20, 1884		Broughton, Frank, University of London, Burlington-gardens, W.
May 4, 1876	Trans.	Brown, Adrian John, 6, Alexandra-road, Burton-on-Trent
Dec. 5, 1867	Trans.	Brown, Dr. A. Crum, F.R.S., 8, Belgrave-crescent, Edinburgh
Mar. 17, 1870		Brown, David, 93, Abbey-hill, Edinburgh
June 18, 1891		Brown, Edward, 32, Courlandsky-street, St. Petersburg, and care of Wm. Brown, Heaton-street, Cleckheaton
Mar. 20, 1873	Trans.	‖Brown, Frederic Douglas, Prof., B.Sc., Univ. Col., Auckland, New Zealand
Mar. 20, 1884		Brown, Frederick William, 47, Elgin Avenue, St. Peter's Park, W.
May 5, 1892		Brown, George Fitz, The Brougton Copper Company, Ditton, Copper Works, Widnes
June 17, 1880		Brown, Henry, Cannon Brewery, Watford, Herts
Jan. 19, 1871	Trans.	†Brown, H. T., F.R.S., 74, Addison-road, Kensington, W.
Mar. 7, 1867	Trans.	‖Brown, James Campbell, D.Sc., University College, Liverpool
Mar. 16, 1881		Brown, Joseph, Ashleigh House, Savile Town, Dewsbury
May 4, 1893		Brown, Ralph E., Perranporth, Truro, Cornwall
May 5, 1882		Brown, Reginald B., Ellerslie, Knighton Park-road, Leicester
Feb. 19, 1891		Brown, Robert John, The Technical School, Stockport
Dec. 18, 1884		Brown, William George, Ph.D., Washington, and Lee University, Lexington, Virginia, U.S.A.
Dec. 7, 1893		Browne, Frank, Government Civil Hospital, Hong Kong

† Longstaff Medallist, 1894.

Date of Election.		
Feb. 20, 1873		Brownen, George, 16, Althorpe-road, Upper Tooting, S.W.
Dec. 4, 1890		Brownsword, Frank, Thorn Villa, Heaton Moor, Stockport
Dec. 6, 1888		Brunker, James Edward, M.A. Univ. Dublin, Minore, St. Kevin's-park, Rathmines, Dublin
Dec. 7, 1893		‖Brunton, John Dixon, Wire Mill, Musselburgh, near Edinburgh
June 21, 1877	Trans.	Buch, Carl von, 11, Queen Victoria-street, E.C., and 1, St. James'-street, S.W.
June 21, 1877		Buchanan, J. Y., F.R.S., 10, Moray-place, Edinburgh
May 4, 1893		Buchanan, Joshua, Rondfontein Estate, G.M.Co., Box 73, Kondersdorp, S.A.R.
June 1, 1876		‖Buckmaster, C. A., 16, Heathfield-road, Mill-hill Park, Acton, W.
Mar. 1, 1852	Trans	‖Buckton, G. B., F.R.S., Weycombe, Haslemere, Surrey
June 20, 1878		Budden, E. Russell, 11, Furnival-street, Holborn, E.C.
Dec. 20, 1842		Bullock, Lloyd, 3, Hanover-street, Hanover-square, W.
Feb. 2, 1888		Bunn, Peter Coulson, junr., 18 and 19, Fenchurch-street, E.C.
Dec. 3, 1891		Burford, Samuel Francis, Eastleigh, Queen's-road, Leicester
Feb. 15, 1894		Burgess, Herbert Edward, 144, Warwick-street, Eccleston-square, S.W.
Dec. 5, 1889		Burgess, John, 7, Wellington-road, Peckham
June 19, 1884		Burgess, William Thomas, F.I.C., 1, Ringley Cottages, Black-borough-road, Reigate
Feb. 21, 1884		‖Burland, Jeffrey H., care of B. R., American Bank Note Company, Ottawa, Canada
Mar. 19, 1849	Trans.	Burnard, Charles F., Plymouth Chemical Works, Plymouth
April 15, 1886		Burnett, Edwin, E., 118, Huddleston-road, Tufnell Park, N.
June 4, 1885		Burnett, Joseph Fearon, Worcester-street, Oxford
May 4, 1893		Burnett, William Robert, Leach Lea, Dunbeth-avenue, Coatbridge, N.B.
May 4, 1893		Burnham, John Charles, Gunpowder Factory, Kirkee, Poona, India
May 4, 1882		Burrell, B. Arthur, 5, Mount Preston, Leeds
Mar. 6, 1890		Burton, William, Clifton Junction, near Manchester
Feb. 21, 1884		Bush, Richard A., Holmdale, Baron-grove, Mitcham
Feb. 16, 1882		Bush, Baron William de, Thornleigh, Sydenham Hill, S.E.
Dec. 5, 1889		Butcher, W. F., 32A, Lea-terrace, Blackheath, S.E.
Dec. 4, 1890		Butcher, William J., The Grammar School, Ashburne, Derbyshire
Dec. 4, 1890		Butler, William Waters, The Cedars, Duchess-road, Edgbaston, Birmingham
June 3, 1875		Butterfield, J. C., 79, Endlesham-road, Balham, S.W.
Feb. 18, 1892		Butterfield, W. J. Atkinson, Beckton, E.
Dec. 15, 1892		Buttfield, Horace Vincent, 13, Wellington-road, Bush Hill Park, Enfield, N.
Dec. 6, 1888		Byrn, George Alexander, Sydney Technical College, Ultimo, Sydney, New South Wales
Feb. 19, 1891		Byrne, Thomas, 18, Lower Kevin-street, co. Dublin

Date of Election.		
June 15, 1893		‖Cahill, Robert S., 9, Park-lane, Norwich
Feb. 15, 1894		Cain, John Cannell, D.Sc., Stubbins Villa, Stubbins, near Manchester
Dec. 3, 1891		‖Calder, William A. S., Cawdor, Grove Park, Camberwell
June 19, 1884		Caley, Edward J., Eaton Old House, Norwich
Dec. 21, 1871		Calvert, J. H., Oakenshaw Print Works, near Accrington
June 17, 1875		Cameron, J. Macdonald, M.P., F.G.S., F.I.C., 5, Raymond-buildings, Grays' Inn, W.C.
May 4, 1893		Cameron, James, Nobel's Explosives Company, West Quarter Factory, Polmont-station, N.B.
Dec. 15, 1892		Campbell, Andrew, The Palens, Dunmeedaw, Rangoon, Burmah
Dec. 6, 1888		Campbell, John Morrow, B.Sc., c/o J. Morrow, Esq., Oakfield House, Anfield, Liverpool
June 7, 1888		Campbell, Rev. Joseph, Coogee, New South Wales
Mar. 20, 1884		Cannon, Matthew, Lavender Hill, S.W.
Feb. 16, 1888	Trans.	Carey, Alfred Edward, M.Inst.C.E., F.R.G.S., F.G.S., 9, Dean's-yard, Westminster, S.W.
May 5, 1892		Carey, Arthur, B.Sc., Browside, Gateacre, near Liverpool
June 20, 1889		Cargill, William D., B.Sc., Loughaugh, near Dundee
Feb. 21, 1889		Carmody, P., Prof., F.I.C., Government Laboratory Port of Spain, Trinidad
May 6, 1875		‖Carpenter, H. S., F.I.C., 32, Holborn-viaduct, E.C.; and Beckington House, Weighton-road, Anerley, S.E.
Nov. 17, 1887		Carrington, George Carrington, Missenden Abbey, Great Missenden, Bucks
Dec. 7, 1882		‖Carruthers, Robert, 90, High-street, Dumfries
Dec. 7, 1893		Carswell, Thomas Retson, 369, Letswood-road, Newcastle-on-Tyne
June 16, 1864		Carteighe, Michael, 180, New Bond-street, W.
Jan. 17, 1853		Carteighe, John, 3, Hereford-square, South Kensington, S.W.
Dec. 5, 1867		‖Carulla, F. J. R., 84, Argyle-terrace, Rose Hill, Derby
Feb. 6, 1879		Cassal, C. E., Vestry Hall, Mount-street, Grosvenor-square, W.
Mar. 20, 1884		‖Cave, Herbert, B.A., Oxon, 11, Pelham-place, South Kensington
Mar. 5, 1874		Chaloner, George, 30, Weston-park, Crouch End, N.
Dec. 2, 1880		Chamberlain, A. G., Rugby
Dec. 20, 1883		Chambres, Gordon Crewe, Rev., Head Master, Wigan Grammar School, Cheshire
Feb. 1, 1883		‖Chance, Alexander M., Lawn-side, Edgbaston, Birmingham
Feb. 1, 1872		‖Chandler, Charles F., Ph.D., School of Mines, Columbia College, 49th-street and 4th-avenue, New York
Feb. 1, 1872		Chandler, William H., Prof., Lehigh University, Bethlehem, Pennsylvania
Dec. 7, 1893		Chaney, Harry, J., 29, Chalcot-crescent, Regent's Park, N.W.
Feb. 21, 1884		Chantrell, Percy S., 3, Temple-road, Oxton, Cheshire

Date of Election.		
Feb. 21, 1889		‖Chaplin, Edward Mitchell, Ph.D., Westgate, Wakefield
June 17, 1886	Trans.	Chapman, Alfred C., F.I.C., The Laboratory, 23, Euston Buildings, N.W.
Jan. 16, 1868		Chapman, Edward, 60, High-street, Oxford
Dec. 18, 1884		Chapman, Herbert M., The War and Sporting Smokeless Powder Company, Frimly, Suffolk
May 7, 1891		Charles, Rhys Pendrill, Plâs Newydd, Neath
Feb. 15, 1894		Chattaway, F. D., St. Bartholomew's Hospital, E.C.
Dec. 4, 1890		Cheetham, T. A., Allan Glen's School, 68, North Hanover-street, Glasgow
April 21, 1887		Chenhall, James Warne, Dart Villas, Totnes, South Devon
Dec. 5, 1878		Cheshire, H. F., Public Analysts' Laboratory, Hastings
Jan. 19, 1882		‖Chester, Edward D., Nutfield, King Charles-road, Surbiton
Dec. 3, 1891		‖Chorley, John C., 85, Haverstock Hill, N.W.
Dec. 16, 1875		Cheverton, George, F.L.S., South Lawn, Tunbridge Wells
Mar. 15, 1888		Chiddey, Alfred, Sabandija Estate, c/o John Owen, Esq., Tolima Mining Co., Tolima, Republic of Columbia
Jan. 16, 1868		‖Child, Gilbert W., Holywell Lodge, Oxford
Dec. 21, 1871		Childs, Christopher, M.D., Oxon, Lindisfarne, Weymouth
June 18, 1874		Christopher, George, Walkden Works, Verney-road, South Bermondsey, S.E.
Dec. 17, 1885		Christopher, Robert G., 35, Chauntler-road, Custom House, Victoria Docks, E.
Dec. 7, 1882		Chrystal, William J., 7, West George-street, Glasgow; and Shawfield Works, Rutherglen, near Glasgow
Mar. 3, 1856	Trans.	Church, Arthur Herbert, F.R.S., Shelsley, Kew, Surrey
Feb. 15, 1894		Chuni Lal Bose, Prof., 24, Mohendra Bosé Lane, Calcutta
April 19, 1888	Trans.	Claisen, Ludwig, Ph.D., Chemisches Laboratorium, Technische Hochschule, Aachen, Prussia
Dec. 15, 1892		Clark, Ernest Victor, Royal College of Science, Dublin
Dec. 7, 1876	Trans.	Clark, John, Ph.D., 138, Bath-street, Glasgow
Feb. 16, 1852	Trans.	Claudet, Frederic, 6, Coleman-street, E.C.
April 15, 1886		Clayden, Arthur W., M.A., F.G.S., St. John's, Polsloe-road, Exeter
Dec. 7, 1882		Clayton, E. Godwin, F.I.C., Chemical Laboratory, 43 and 44, Holborn-viaduct, E.C.
May 4, 1893		Clayton, George, School of Pharmacy, 100, Burlington-street, Manchester
Feb. 21, 1889		Clayton, John William, Benfield, Alma-road, Aigburth, Liverpool
Dec. 4, 1873	Trans.	Cleminshaw, Edward, M.A., Alkali Works, Oldbury, near Birmingham
May 20, 1875		Clerk, Dugald, Driffield Villa, Manor Hill, Sutton Coldfield
May 19, 1856		Clift, Samuel, 63, Dudley-road, West Bromwich

Date of Election.		
Feb. 7, 1878		Cloud, Thomas Charles, A.R.S.M., Walaroo Smelting Works, Walaroo, South Australia
Mar. 18, 1869	Trans.	‖Clowes, Frank, D.Sc., University College, Nottingham
Feb. 3, 1887		Coutes, William Henry, M.A., M.B., L.S.Sc., M.R.C.S., L.R.C.P., L.S.A., Bleak House, Patrington, Yorkshire
Mar. 6, 1890		Cobbold, Paul Alexander, Hailsbury vià Mattawa, Ontario, Canada
Dec. 18, 1879		Cochran, Michael, M.A., Wiesbaden, Kollupitiza, Columbo, Ceylon
Dec. 2, 1880		‖Cockburn, Arthur Cecil, 22, Streatley-road, Brondesbury, N.
June 16, 1892		Cockerill, Thomas, 105, Derby-street, Bolton
Dec. 7, 1893		Cocking, Allan Thomas, Oscott House, Heathfield-road, Handsworth, Birmingham
Feb. 16, 1888		Cocking, Lewis Smith, Wharf Mills, Apsley, Huddersfield
Feb. 17, 1881		‖Coffin, Walter H., 94, Cornwall-gardens, South Kensington and Junior Athenæum Club, S.W.
Mar. 5, 1885	Trans.	Cohen, Julius B., Yorkshire College, Leeds
Feb. 19, 1891		Cole, Arthur, B.A., Homeleigh, Berkhamsted, Herts
Feb. 19, 1891	Proc.	Colefax, Arthur, Ph.D., B.A., Christ Church, Oxford
April 19, 1883		Coleman, Joseph Bernard, 87, Waldeck-road, Carrington, Nottingham
June 21, 1883		Coleman, Thomas Henry, Regent-street, Wrexham, North Wales
Mar. 1, 1883		Collenette, Adolphus, 11, Commercial-arcade, Guernsey
Nov. 6, 1873		Collens, Edward, Stourport, Worcestershire
June 16, 1881		Collett, John Marton, Guys Cliff, Wotton, Gloucester
Feb. 5, 1885	Trans	‖Collie, J. Norman, Ph.D., University College, W.C.
Feb. 16, 1888		Collins, W. Hepworth, Analytical Laboratory, 14 and 15, Bradford-chambers, Mawdsley-street, Bolton-le-Moors
Feb. 18, 1892		‖Collins, Hugh Brown, B.Sc., West Balgray, Glasgow
Feb. 6, 1890		Collins, Sydney Hoare, Dehow Dunn, North-West Province India
Mar. 17, 1887	Trans.	Colman, Harold G., Ph.D., 29, Noel-road, Edgbaston, Birmingham
May 15, 1890		Colwell, James Kear, F.I.C., 101, Great Russell-street, W.C.
May 5, 1892		‖Comyns, Frank B. A., 55, South-street, Durham
June 18, 1891		Congdon, Prof. Ernest A., The Drexel Institute of Art, Science, and Industry, Chestnut-street, Philadelphia, Penn, U.S.A.
Feb. 18, 1875		Connor, Charles C., B.A., Notting-hill House, Malone, Belfast
April 19, 1883		‖Conrad, Edwin C., Portland-road, Gravesend
Feb. 15, 1877		Conroy, Michael, Woodstock, New Brighton, Cheshire
Jan. 18, 1866	Trans.	‖Conroy, Sir John, Bart., F.R.S., Balliol College, Oxford
April 4, 1889		Cook, Edward Barnwell, Rev., The Vicarage, Hinton Charterhouse, Bath
Dec. 2, 1875	Trans.	Cook, E. H., D.Sc. (Lond.), the Clifton Laboratory, 27, Berkeley-square, Clifton, Bristol

Date of Election.		
Nov. 5, 1874		Cook, Edward Rider, East London Soap Works, Bow
Nov. 5, 1874		Cook, Henry John, East London Soap Works, Bow
Dec. 4, 1890		Cooke, Arthur William, care of Brotherton and Co , Calder-vale, Wakefield
Feb. 2, 1888		Cooke, F. Barker, F.I.C., Messrs. Bostock and Co., South Dock, Garston, near Liverpool
Nov. 15, 1888		Cooley, Walter Bromley, 5, Dudley-street, Wolverhampton
May 18, 1857		Coomber, Thomas, Rosehurst, Clarendon-road, Redland, Bristol
Jan. 17, 1889		Cooper, Albert, Grimston Lawn, Haven Green, Ealing, W.
Dec. 15, 1892		Cooper, Arthur James, Queen Elizabeth's School, Bromyard, near Worcester
Feb. 16, 1888		Cooper, Astley, Oaklands Chemical Works, Meanwood-road, Leeds
Dec. 15, 1892		Cooper, Lionel, Analytical Laboratory, 173, Marylebone-road, N.W.
May 7, 1891		Cooper, Walter Johnson, South Wales Cement Works, Penarth, near Cardiff
April 15, 1880		Copas, Edwin Charles, M.A., The Grammar School, Handsworth, Birmingham
May 15, 1890		Copeman, Sydney Monckton, M.A., M.D. (Cantab), Local Government Board, Whitehall, S.W., and 9, Duke-street, St. James, S.W.
Feb. 19, 1891	Trans.	Corbett, Charles Henry, the Avenue, Troubridge, Wilts
Mar. 1, 1866		‖Corfield, W. H., M.A., M.D. (Oxon), F.G.S., Professor of Hygiene and Public Health, University College, W.C., and 19, Saville-row, W.
Dec. 3, 1891		Cory, George Edward, M.A. (Cam.), the Drostdy, Grahamstown, South Africa
Dec. 6, 1888		‖Cornish, Vaughan, 1, St. James' Terrace, Winchester
April 17, 1890		Corrie, David, Nobel's Explosives Company, West Quarter Factory, Polmont Station, N.B.
June 15, 1876		Cortis, Arthur B., Worthing, Sussex
Dec. 5, 1889		Coste, F. H. Perry, B.Sc., F.L.S., 142, Burnt Ash-hill, S.E.
June 15, 1893		Coste, John Henry, 69, Goswell Road, E.C.
June 16, 1892		Couldrey, Henry, H.M.'s Mint, Bombay, India
Dec. 17, 1885		Cousins, William J., 11 and 12, Southampton-buildings, Chancery-lane, W.C.
Dec. 16, 1886	Trans.	‖Coutts, Francis J. H., Green Mount, Plymouth-grove, Manchester
Dec. 7, 1882		‖Cowie, Thomas R., Rangoon Chemical Company, Rangoon
Feb. 6, 1873		Cownley, Alfred J., 13, Fenchurch-avenue, E.C.
April 19, 1888		Cowper, Joseph, 50, King-street, Penrith
Dec. 2, 1886		Cox, Ebenezer John, Orwell Bank, Greenwell-road, Harborne, Birmingham
Dec. 4, 1873		Cox, Samuel Herbert, 13. St. Helen's-place, London, E.C.
Dec. 1, 1870	Trans.	Crafts, Prof. J. M., 59, Marlborough-street, Boston, Mass., U.S.A.

Date of Election.		
Dec. 15, 1892		Craig, Andrew William, 77, Peel-street, North Melbourne, Victoria
June 3, 1875		||Crampton, George, St. George's Club, Hanover-square, W.
Dec. 7, 1893		Craw, John A., 2, Millgate, Cupar, Fife
Mar. 16, 1882		||Crawley, H. Howard, Saugeen, Bournemouth
May 20, 1875		Cresswell, Charles Gerard, Ermyngarth, Ashtead
Mar. 3, 1887		Cribb, Cecil H., B.Sc., 62, Shaftesbury-avenue, W.
April 4, 1889		Cridland, Francis E. J., Analytical Laboratory, 192, Palmerston-buildings, Old Broad-street, E.C.
June 20, 1878		Criper, William Risdon, Cossipore Chemical Works, 3½, Hastings-street, Calcutta
May 20, 1886	Trans.	||Crompton, Holland, Fairholme, Fulham-road, Fulham, S.W.
Dec. 3, 1857	Trans.	Crookes, William, F.R.S., 7, Kensington Park-gardens, W., and Athenæum Club, Pall Mall, S.W.
Feb. 6, 1879	Trans.	Cross, Charles Frederick, 4, New-court, Lincoln's-inn, W.C.
Dec. 4, 1890		Crossley, Arthur W., B.Sc. (Vict.), Ph.D., Universitats, Chemisches Laboratorium, Berlin
Dec. 2, 1880		Crow, John Kent, D.Sc., 32, Rosemount-road, Acton, W.
Dec. 1, 1887		||Crowther, H. Woodward, Beeches-road, West Bromwich
June 19, 1884		Crumbie, William D., 146, Washington-street, East Orange, New Jersey, U.S.A.
Mar. 5, 1874		Cruse, F. V. L., Neva Stearin Works, 65, Schlusselburg-road, St. Petersburg, Russia
Mar. 17, 1887	Trans.	Cundall, J. Tudor, The Academy, Henderson-row, Edinburgh
April 4, 1889		Cunningham, A. Anchie, 426, Kearny-street, San Francisco
Dec. 27, 1875		Curphey, W. S., 2, Princes-square, Strathbungo, Glasgow
Feb. 21, 1889		Curragh, John, Donaghadee, Belfast
Dec. 15, 1881		||Custance, John D., Prof. of Agriculture, Gurnard, Cowes, Isle of Wight
Feb. 15, 1894		Dains, Herbert H., F.I.C., 3 Cantonment, Vizianagrum, India
Dec. 7, 1882		Dampier, Henry L., Frinsbury-road, Strood, Kent
June 16, 1887		Daniell, L. C., Royal Standard Brewery, Tamworth, N.S.W.
April 15, 1850		||Danson, Joseph, Montreal, Canada
Feb. 18, 1892		Darbishire, Francis V., Rossplatz 12, I., Leipzig
Nov. 15, 1852		Darby, Stephen, 140, Leadenhall-street, E.C
Dec. 3, 1891	Trans.	Darling, Thomas, 1, Palace-street East, Berwick-on-Tweed
May 4, 1871		Darling, William Howarth, 126, Oxford-street, Manchester
Nov. 18, 1886		Davenport, Bennett F., M.A., M.D., 161, Tremont-street, Boston, Mass., U.S.A.
Nov. 18, 1875		||Davey, G. W., Cambridge-road, Barking, Essex
Feb. 16, 1893		Davey, George, c/o Michoacau Railway Mining Company, Maravater, Mexico
May 18, 1876		Davidson, Joseph, Holywell-green, Halifax

Date of Election.		
June 16, 1881		Davies, Alfred Edgar, Mayfield-road, Aigburth, Liverpool
Feb. 1, 1866	Trans.	‖Davies, Arthur E., Ph.D., Tweedbank, West Savile-road, Edinburgh
Feb. 16, 1893		Davies, D. O. Sydney, Springwood, Uttoxeter
May 6, 1858	Trans.	Davies, Edward, The Laboratory, 28, Chapel-street, Liverpool
Feb. 16, 1882	Trans.	Davies, G. W., Spring-hill, Stockport
May 5, 1892		Davies, Joseph, 28, Robarts-road, Anfield
Dec. 17, 1857		‖Davis, J. Frederick, F.G.S., Archbrook, Budleigh-Salterton, Devon
June 6, 1872	Trans.	‖Davis, Richard Hayton, 26, Regent-parade, Harrogate
Jan. 20, 1876		Davis, T. Sebastian, 199, South Lambeth-road, S.W.
Dec. 7, 1876		‖Davis, Walter Charles, The Manse, Prestonville-road, Brighton
June 15, 1893		Davy, S. H. M., Sharrow-view, Sharrow, Sheffield
Feb. 2, 1888		Day, Albert Wodehouse, B.A., 38, Hava-villas, West Brighton
Nov. 20, 1890		Day, Charles Edwin, 145, Abbey-road, Barrow-in-Furness
Mar. 17, 1881	Trans.	‖Day, T. Cuthbert, 36, Hillside-crescent, Edinburgh
Mar. 3, 1859	Trans.	Debus, Heinrich, Ph.D., F.R.S., 1 Obere Sophien-strasse, Cassel, Provinz Hessen, Germany
May 7, 1885	Trans.	Dechan, Martin, Chemical Laboratory, 5, Oliver-place, Hawick
Dec. 3, 1874		Deck, Arthur, 9, King's-parade, Cambridge
April 1, 1869	Trans.	Deering, W. H., Endsleigh, Glaudice-road, Westcombe Park, S.E.
Dec. 15, 1881		Demarcay, Eugene Anatole, 75, Rue de Courcelles, Paris
Dec. 15, 1892		Denison, Joseph R., 1, Park-view-terrace, Manningham, Bradford
Mar. 6, 1890		Dennant, John, F.G.S., Prospect Hill-road, Camberwell, Victoria
Dec. 1, 1870	Trans.	Dewar, James, Prof., F.R.S., 1, Scroope-terrace, Cambridge
Mar. 4, 1886		‖Dey, Preo Loll, 4, Beadon-street, Calcutta
June 17, 1880		Dey, Rai Kanny Loll Bahadoor C.I.E., 4, Beadon-street, Calcutta
April 15, 1880		Dibdin, W. J., F.I.C., Mayfield, Grange-road, Sutton, Surrey
April 18, 1872		Dickenson, Arthur John, F.I.C., 4, Shadeloes-road, New Cross, S.E.
May 4, 1893		Dickinson, Henry Winram, Kent-place, Ulverston, Lancashire
Dec. 1, 1887		Dickson, T. Arthur, Estate Office Overstone Park, Northampton
Jan. 17, 1889		Dinsberg, Dr. Carl, Elberfield, Germany
June 7, 1886		Diogo, Prof. A. C., Hospital Militar, 29 Rua do Evaristo da Veiga, Rio de Janeiro
Feb. 2, 1860	Trans.	‖Divers, Edward, Prof., M.D., F.R.S., Hongo, Tokyo, Japan
Feb. 5, 1885	Trans.	Dixon, Augustus Edward, M.D., Queen's College, Cork
Feb. 3, 1876	Trans.	‖Dixon, Harold B., F.R.S., Owen's College, Manchester
May 4, 1893		Dixon, Harry W., 20, Moor-crescent, Hunslet, Leeds
Dec. 18, 1862		Dixon, W. A., Technical College, 301, Pitt-street, Sydney, New South Wales

Date of Election.		
Jan. 17, 1889		Dixon, W. Hepworth, Heatherdale, Woodford Green, Essex
April 17, 1890		Dixon, William, 3, Belle Vue Park, Sunderland
June 15, 1882	Trans.	Dobbie, James Johnstone, M.A., D.Sc. University College, Bangor, N. Wales
Mar. 3, 1887		Dobbin, Leonard, Ph.D., Chemical Laboratory, New University, buildings, Edinburgh
Dec. 2, 1875	Trans.	Dodd, T. H., Chemical Department, Royal Arsenal, Woolwich, S.E.
April 19, 1888		‖Dodd, William Henry, 8, Kempson-road, Telbrook, Fulham, S.W.
Nov. 18, 1886		Dodd, W. Ralph, 2, St. Andrew's-pavement, Dunmore-road, Amhurst-park, N.
May 5, 1892		Dodds, George Price, 14, Cardigan-terrace, Heaton, Newcastle-on-Tyne
May 5, 1892		Donaldson, Hudson, Trevyr House, Grantham
Feb. 19, 1891		Donovan, Hendric Thomas, Crumpton-street, Bridgetown, Barbadoes, B.W.I.
May 20, 1886		Doran, Robert Elliott, 1, Goldsmith-terrace, Bray, co. Wicklow
May 20, 1886		Dormer, Richard, Garston.
Dec. 5, 1889		Dott, David Brown, Windsor Cottage, Musselburgh, N.B.
Dec. 6, 1888		Douglas, William, A.I.C., 35, Varley-road, Stamford Hill, N.
Nov. 20, 1884		Down, Frederick J., 28, Victoria-road, Old Charlton, Kent, S.E.
Feb. 3, 1887		Downes, Arthur H., M.D., Local Government Board, Whitehall, S.W.
Feb. 21, 1884		Draper, Henry Carter, Weston, Alma-road, Monkstown, co. Dublin
June 18, 1891		Dreaper, W. Porter, Crape Silk Works, Ponders End, Middlesex, N.
March 4, 1886		Dresel, Adolphe, 64, Billiter-buildings, Billiter-street, E.C.
Feb. 16, 1893		Dreyfus, Charles, Ph.D., The Clayton Aniline Co., Clayton, Manchester
Dec. 4, 1890		‖Dudley, William L., Professor, Nashville, Tennessee, U.S.A.
Feb. 16, 1893		‖Dufton, Samuel Felix, B.A., D.Sc., 6, Park-road, Red Hill, Surrey
May 5, 1892		Duffield, Walter William, 24, Ursula-street, Battersea, S.W.
Feb. 21, 1884		Duggan, T. R., Sunny-bank, Vanbrugh-hill, Westcombe-park, Blackheath, S.E.
Dec. 5, 1889		Dukes, Thomas William, c/o Dukes Bros., Caledon and Primrose-street, Cape Town, Africa
June 16, 1881		Duncan, Arthur William, c/o Messrs. Woolley, Sons, & Co., Victoria Bridge, Manchester
Dec. 17, 1863		Duncan, James, 9, Mincing-lane, E.C.
Feb. 15, 1894		Duncan, Dr. John, St. Petersburg, Russia
June 18, 1891		Duncan, William, The Laboratory, 65, Bath-row, Edgbaston, Birmingham

Date of Election.		
June 7, 1888	Proc.	Dunn, John, B.Sc., Morgan Academy, Dundee
Dec. 7, 1882		Dunn, J. T., M.Sc., The School, Gateshead-on-Tyne
Feb. 15, 1894		Dunne, Basil Leonard, B.A., R.U.I., A.I.C., A.R.C.Sc., Royal University of Ireland, Dublin
Feb. 16, 1893		Dunnington, Francis P., University of Va, Charlottesville, U.S., N.A
Dec. 3, 1885		Dunstan, M. J. R., M.A., F.R.S.E., 9, Hamilton Drive, The Park, Nottingham
Dec. 18, 1879	Trans.	Dunstan, Wyndham, Prof., M.A., F.R.S., 17, Bloomsbury-square, W.C.
Jan. 19, 1860	Trans.	Dupré, August, Ph.D., F.R.S., Westminster Hospital Medical School, Caxton-street, Westminster, S.W.
Feb. 16, 1860		Dupré, Frederick, Ph.D., Stassfurt, near Magdeburg, Germany
June 1, 1871		||Durham, Henry, City of London School, Victoria Embankment, E.C.
Dec. 6, 1883		Durrant, Reginald G., B.A., The College, Marlborough, Wilts
Dec. 6, 1883		Dutta, Ramchandra, Medical College, Calcutta
Dec. 15, 1892		Duxbury, Thomas, The Corporation Gas Works, Darwen
Dec. 16, 1875	Trans.	||Dyer, Bernard, D.Sc. (Lond.), 17, Great Tower-street, E.C.
Feb. 6, 1890	Trans	Dymond, Thomas Southall, The Limes, New-street, Chelmsford
Nov. 19, 1885		Dyson, Gibson, Ph.D., Temple House, Cheetham Hill, Manchester
Mar. 1, 1883	Trans.	Dyson, Septimus, Frizinghall, Bradford
Dec. 7, 1882		Earl, Alfred George, M.A., Science-buildings, Tonbridge School, Tonbridge
Feb. 1, 1876		Earp, Francis S., Ph.D., c/o Dr. Astles, Angus-street, Adelaide. South Australia
April 4, 1889	Trans.	Easterfield, Thomas Hill, M.A., Ph.D., 5, St. Andrew's Hill, Cambridge
Dec. 3, 1891		Eastick, Charles E., Grove-terrace, Grove-road, Leytonstone
Feb. 1, 1881		Eastick, John J., Manager, Australasia Sugar Refining Co., Melbourne, Australia
Dec. 5, 1878	Trans	||Eccles, Herbert, Briton Ferry, Glamorgan
Mar. 17, 1881		Edgell, R. Arnold, Rev., M.A., The College House, Leamington
June 1, 1876		Edmunds, James, M.D., 29, Dover-street, Piccadilly, W.
June 22, 1888		Edmunds, Lewis, Barrister-at-Law, 1, Garden-court, Temple, E.C., and 60, Park-street, Park-lane, W.
Feb. 7, 1848	Trans.	||Edwards, John B., Ph.D., Montreal
Dec. 5, 1889		Edwards, Robert Stephen, B.A., Mosley House, Gelert-street, Carnarvon
May 4, 1893		Edwards, Thomas, Brewery House, Rhymney, viâ Cardiff
Feb. 21, 1884		Edwards, Vincent, Lawes' Chemical Manure Co., Barking Creek, Essex
May 5, 1892		Edwards, Walter N., 4, Herne Hill-road, Camberwell, S.E.

Date of Election.		
June 16, 1887		||Ehrhardt, Ernest Francis, D.Sc., Ph.D., A.M.C. Anilinfabrik, Ludwigshafen-am-Rhein
Nov. 20, 1884		Ehrmann, Leon, The Mauritius Engrais Chemiques Co., Port Louis, Mauritius
Dec. 1, 1864	Trans.	Ekin, Charles, 143, New Bond-street, W.
Dec. 20, 1883		Ekins, Arthur E., Market-place, St. Albans
Nov. 17, 1887		Elborne, William, B.A. (Cantab.), 35, Abbey-gardens, St. John's Wood, N.W.
Dec. 3, 1891	Trans.	Elford, Percy, St. John's College, Oxford
Feb. 7, 1878		Elliott, Arthur H., Ph.D., c/o Consolidated Gas Co., 4, Irving-place, New York City, U.S.A.
Dec. 7, 1893		Ellis, Charles S., 17, Bloomsbury-square, London, W.C.
April 17, 1890		Ellis, Thomas Flower, The Straits Trading Co., Pulo Brani Smelting Works, Singapore
Feb. 7, 1878		Ellis, W. H., School of Practical Science, Toronto, Ontario, Canada
May 5, 1892		Ellison, Henry, junr., Whitechapel-road, Cleckheaton
Mar. 15, 1888		Ellwood, Thomas Ashcroft, 110, Rosebery-square, Rosebery-avenue, E.C.
Feb. 16, 1893		Elmore, Alexander Stanley, Esq., Oulton-green, Oulton, Yorks.
Mar. 4 1886	Trans.	Elworthy, Herbert Samuel, 4, Hill-road, Paudra, Bombay, India
Feb. 5, 1885		Embrey, George, Oriel Lodge, Tuffleigh, near Gloucester
Feb. 3, 1887		||Emmons, Hamilton, c/o N. H. Emmons, Esq., 40, Water-street, Boston, Mass, U.S.A.
June 16, 1892		Entwistle, Herbert, 68, Yarburgh-street, Whalley Range, Manchester
Dec. 3, 1885		Epps, James, junr., Norfolk House, Beulah Hill, Upper Norwood, S.E.
Dec. 5, 1889		Erskine, J. Kerr, Box 73, Baudfontein Estates, G.M.P.M., Krugersdorf, Transvaal, South Africa
June 21, 1883	Trans.	Esilman, Alexander, Fleetwood Lodge, 25, Roe-lane, Southport
May 1, 1862		||Esson, William, F.R.S., Merton College, Oxford
Feb. 2, 1865		||Estcourt, Charles, St. Andrew's-chambers, 20, Albert-square, Manchester
Feb. 2, 1888		||Estcourt, Philip Anderson, Chemical Laboratory, 20, Albert-square, Manchester, and Vyrmew House, Talbot-road, Old Trafford, Manchester
Mar. 17, 1887		Evans, Alfred J., M.A., B.Sc., 453, Romford-road, Forest Gate, E.
May 7, 1891		Evans, Frederick Arthur, The Cape Copper Co., Ookiep, Namaqualand, Cape of Good Hope
June 15, 1876		Evans, Gwilym, 7, Stepney-street, Llanelly, South Wales
May 17, 1888		Evans, George Thomas, The Terrace, Rhymney, Mon.
May 4, 1893		||Evans, Robert Cecil Turle, 6, Gower-street, W.C.

Date of Election.		
June 16, 1892		Evans, Sir John, K.C.B., F.R.S., Nash Mills, Hemel Hempstead
Dec. 6, 1888		‖Everard, Arthur George, 27, Northcote-road, Clapham Junction, S.W.
Feb. 15, 1894		Evershed, Frank, Kenley, Surrey
Feb. 17, 1876		Faber, H. M., Rev., 1, College-grounds, Malvern
Mar. 15, 1888		Faber, Harald N., Fiona, Lennard-road, Penge, S.E.
May 18, 1865	Trans.	‖Fairley, Thomas, F.R.S.E., 8, Newton-grove, Leeds; and 16, East-parade
Feb. 1, 1883		Fallon, J. H. M., c/o. Peruvian Corporation, Ltd., Lima, Perù
Nov. 15, 1888		Farlie, John B., 128, Eglington-road, Plumstead, S.E.
Feb. 6, 1890		Farquharson, A. C., County Asylum, Lichfield
Dec. 1, 1870		Farries, Thomas, 16, Coleman-street, E.C.
Dec. 2, 1880		‖Farrington, Thomas, M.A., 4, Waterloo-place, Cork
Feb. 15, 1894		Fawcett, Joseph Addey, 153, Malpas-road, Brockley, S.E.
Dec. 1, 1887		Fawsitt, Charles A., 9, Foremount-terrace, Dowanhill, Glasgow
June 7, 1888		Featherstone, W. Burns, Mansion House, Moseley, Birmingham
May 17, 1888		Fell, John Campbell, 188, Stanhope-street, Regent's-park, N.W.
Dec. 5, 1878	Trans.	Fenton, H. J. H., M.A., Christ College, Cambridge, and 7, Mortimer-road, Cambridge
June 20, 1872		‖Ferguson, John, Prof., M.A., University of Glasgow
Feb. 4, 1864		‖Ferreira, A. A., M.P.S., Rio de Janeiro, Brazil
Feb. 21, 1889		Ferrier, David, Edinburgh-terrace, Edinburgh-road, Perth
Nov. 16, 1882		Ferrier, James, care of Dr. David Ferrier, F.R.S., 34, Cavendish-square, W.
Dec. 4, 1873		Field, Charles L., Upper Marsh, Lambeth, S.E.
May 15, 1890		Findlay, George H., The Brewery, Boro' Bridge, Yorks
Mar. 7, 1872	Trans.	‖Fisher, Walter William, M.A., 5, St. Margaret's-road, Oxford
April 3, 1873		Fison, Edward Herbert, Stoke House, Ipswich
April 18, 1872		Fison, Frederick William, M.A., 98, Cromwell-road, S.W.
Feb. 15, 1894		FitzGerald, Henry Purefoy, B.A., Wellington College, Berks
Dec. 19, 1867		Fletcher, A. E., 13, Christchurch-road, Crouch End, N.
April 16, 1874		Fletcher, Frederick W., North London Chemical Works, Holloway, N., and Beauchamp Lodge, Enfield
Dec. 3, 1885		‖Fletcher, Lazarus, M.A., F.R.S., 36, Woodville-road, Ealing London, W.
April 18, 1872	Trans.	‖Fletcher, Thomas William, Grappenhall, Warrington
Feb. 18, 1892		Floris, Robert Brooks, Grandtully, Shrewsbury-road, Stonebridge Park, Willesden, N.W.
June 16, 1859		Fogg, Thomas, 6, Clarendon-gardens, Maida-vale, W.
Dec. 5, 1889		Foggie, John, University College, Dundee
May 7, 1885		Follows, Harold, 142, Embden-street, Manchester
Feb. 21, 1853		Foord, George, Royal Mint, Melbourne, Australia

Date of Election.		
Nov. 19, 1874		Forbes, James, jun., 70, Gracechurch-street
Dec. 5, 1889		Ford, John S., care of Messrs. W. Younger and Co., Abbey Brewery, Edinburgh
Mar. 4, 1886		Formoy, James Arthur, 12, Railway-approach, London Bridge
Dec. 7, 1893		Forrester, Alexander M., Laboratory, Port Dundas Chemical Works, 20, Canal-bank, Glasgow
Dec. 15, 1892		||Forster, Dr. Martin Onslow, 44, Francis-road, Edgbaston, Birmingham
Mar. 3, 1856		Forsyth, William Cay, 128, Wellington-road, Heaton Norris, Lancs.
Dec. 6, 1888		Forth, Henry, Regent-street, New Basford, Nottingham
April 6, 1865		Foster, Dr. M., F.R.S., Trinity College, Cambridge
April 4, 1872		Foster, Reginald Le Neve, The Firs, North-road, Droylsden, near Manchester
May 7, 1891		Foster, John Alfred, The Laboratory, H.M.'s Dockyard, Portsmouth
Feb. 2, 1888	Trans.	||Foster, G. C., F.R.S., 18, Daleham-gardens, Hampstead, N.W.
May 7, 1892		Fowler, Gilbert J., Dalton Hall, Victoria Park, Manchester
Mar. 16, 1882		Fowler, William, 1, Grace-terrace, Sunderland
June 19, 1884		||Foye, Martin Hugh, M.B., C.M., Landor House, Boulevards, Weston-super-Mare, Somersetshire
June 21, 1877		Franchimont, A. E. N., Ph.D., Leiden, Holland
Dec. 18, 1879		Francis, Edward, Ivey Bank, Park Valley, Nottingham
Nov. 6, 1873		||Francis, G. Bult, 38, Southwark-street, S.E.
Nov. 7, 1842	Trans.	Francis, William, Ph.D., F.L.S., Manor-house, Richmond, Surrey, and Red Lion-court, Fleet-street, E.C.
Dec. 20, 1847	Trans.	||Frankland, E., D.C.L., F.R.S., The Yews, Reigate-hill, Reigate
June 16, 1881		Frankland, Henry, Streonshalk, Linthorpe, Middlesbro'
Dec. 2, 1880	Trans	||Frankland, Percy Faraday, Ph.D., F.R.S., University College, Dundee
Mar. 21, 1867		||Fraser, Dr. Angus, 232, Union-street, Aberdeen
May 5, 1892		||Fraser, James C., Victoria-square, Adelaide, South Australia
May 7, 1885		Freear, Harry M., Hedgefield, Harpenden, Herts
June 16, 1887		Freeman, Frederick W., 7, Park Hall-place, East Finchley
Mar. 7, 1867		Freeman, J. Hersec, Stratford House, Stratford, E.
April 4, 1889		Freestone, Joseph T., 5, Kerfield-terrace, New Ferry-road, New Ferry, Cheshire
Dec. 15, 1892		French, William, Highfield, Walmersley-road, Bury, Lanc.
April 4, 1889	Trans.	Frew, William, c/o Herrn Hummel, Theresienstrasse 2/1, München, Bayern, Germany
Feb. 2, 1871	Trans.	||Friswell, R. J., 115, Darenth-road, Stamford Hill, N.
Dec. 18, 1884		Frost, Joe, Moldgreen, Huddersfield
Nov. 20, 1890		||Frost, Robert, Brightside, Altrincham
April 15, 1880		Fryer, Alfred Cooper, Ph.D., M.A., 13, Eaton-crescent, Clifton, Bristol

Date of Election.		
Dec. 3, 1891		Fulcher, Lionel William, B.Sc., South Kensington Museum, S.W.
Feb. 16, 1893		Fuller, Frederick George, 19, Brunswick-square, W.C.
Dec. 2, 1886		Fuller, John, Rookwood, Chapter-road, Willesden Park, N.W.
Mar. 1, 1883		Fulton, H. B., 33, St. Dunstan's-road, West Kensington, W.
Feb. 18, 1892		Gailleton, Alfred T., Tulloch House, Perth, N.B.
April 19, 1866		Gale, James, Ph.D., M.A., F.G.S., Galeston, Eton-avenue, South Hampstead
Dec. 20, 1847	Trans.	Galloway, Robert, 60, Pembridge-villas, Bayswater
Mar. 4, 1875		‖Galton, Douglas, Sir, K.C.B., F.R.S., 12, Chester-street, Grosvenor-place, W., and Himbleton Manor, Droitwich
Mar. 17, 1851		‖Gamble, David, Colonel, C.B., St. Helens, Lancashire
April 6, 1876		Gamble, J. C., St. Helens, Lancashire
Dec. 6, 1883		‖Garbutt, Llewellyn, M.D., The College, Winchester
Mar. 15, 1888		Gardiner, James H., 59, Wroughton-road, Balham, S.W.
May 4, 1893	Trans.	Gardner, J. Addyman, Chemical Department, Museum, Oxford
June 21, 1877		Gardner, John, 3, Hanover-street, Hanover-square, W.
Nov. 15, 1888		Gardner, Walter M., The Yorkshire College, and Manor Cottage, Richmond-road, Headingley
May 5, 1892		Gargari, Haridas, M.A., Agra College, Agra, India
Dec. 7, 1894		Garnett, Henry, 2, Bartholomew Villas, Kentish Town, N.W.
Jan. 17, 1889		Garrett, Frederic Chas., B.Sc., The Polytechnic, Woolwich, S.E.
Jan. 20, 1876		‖Gaskell, Ernest Holbrook, 5, The Grove, Highgate, N.
April 17, 1884		Gaskell, Joseph, 1, Woodlands-road, Cheetham-hill, Manchester
Jan. 18, 1847		Gatty, F. A., Holland Bank, Accrington, Lancashire
Nov. 4, 1875		Gee, T. Ernest, F.R.C.P., 67, Westbourne-park-road, W.
Feb. 6, 1890		Gee, W. W. Haldane, B.Sc. Lond., 124, Raby-street, Moss Side, Manchester
Mar. 3, 1887		Geisler, Joseph F., Ph.C., Mercantile Exchange Buildings, Hudson and Harrison-streets, New York
May 7, 1885		Gemmell, George Harrison, 4, Lindsay-place, Edinburgh
April 17, 1879		Gent, William Thomas, Misterton, Gainsborough
Feb. 21, 1889		‖Gerland, Conrad, M.Sc., Ph.D., Chemical Laboratory Technical School, Blackburn; and Accrington
Dec. 3, 1891		German, George, Junr., Huntingdon House, Ashby-de-la-Zouch
Feb. 16, 1888		Gerrans, Benjamin H., jun., 47, Aubert Park, Highbury, N.
Nov. 4, 1875		Gerrard, A. W., Chertsey
Dec. 6, 1888		Geyzel, John Lawrence Van, Surgeon-Major, Chemical Examiner, Madras, East India
Feb. 6, 1890		‖Gibbes, Cuthbert C., M.D., M.C., L.R.C.P. Lond., D.P.H. Cantab., F.G.S., F.L.S., 3, Wyburn-villas, Surbiton, S.W.
May 7, 1891		Gibbins, Bevington H. Ocata, Florida, U.S.A., and Inglescombe, Manor Park, Redland-road, Bristol

Date of Election.		
Feb. 18, 1864		Gibbons, Sydney, Faraday House, East Melbourne, Victoria
May 16, 1889		Gibbs, William Taylor, Buckingham, Que, Canada, viâ New York
Mar. 5, 1885		Gibson, Adam, c/o Messrs. Pinkerton, Gibson & Co., Thistle-street-lane, East Edinburgh
Feb. 21, 1884		Gibson, George W., Headingley, P.O., near Winnipeg, Manitoba, Canada
June 16, 1892		Gibson, John Ph.D., F.R.S.E., F.I.C., 20, George-square, Edinburgh
June 21, 1888		Gibson, W. Humphrey, 122, King's-road, Brighton
May 18, 1841	Trans.	Gilbert, Joseph Henry, Ph.D., F.R.S., F.L.S., Harpenden, St. Albans
April 3, 1862	Trans.	Gill, C. Haughton, Berkeley Lodge, Stroude-road, Staines
Feb. 1, 1883		||Gill, E. Clarendon, Ashford Villa, Gresham-road, Staines, Middlesex
Mar. 17, 1881		Gill, E. J. G., Wellikuppam, Madras Presidency, India
April 19, 1888		Gill, John, Gwealhellis, Helston, Cornwall
April 6, 1865		||Gillman, A. W., Castle Brewery, St. George's-road, Southwark
Dec. 3, 1885		Girdwood, Gilbert P., M.D., 54, Beaver Hall Hill, Montreal, Canada
Dec. 18, 1848	Trans.	Gladstone, John Hall, Ph.D., F.R.S., 17, Pembridge-square, Hyde Park, W.
Mar. 4, 1886		Glenfield, Francis W. S., 27, Gloucester-gardens, Hyde Park-square, W.
Jan. 18, 1872		Glover, George Thomas, The Phospho-Guano Company, Seacombe, Cheshire
April 4, 1878		Goldschmidt, S. A., Ph.D., care of Columbia Chemical Works, 43 to 57, Sedgwick-street, Brooklyn, New York
May 16, 1889		Goldsmith, Byron B., 19, East 74th-street, New York City, U.S.A.
Dec. 15, 1892		Goodall, Walter, Alma House, Pudsey, near Leeds
Dec. 4, 1890		Goodwin, Thomas S., Clyde-terrace, Tollcross, Glasgow
Nov. 20, 1890		Gordon, Colin, Messrs. McDougall Bros., Mills, Millwall Docks, E.
April 21, 1887	Proc.	Gordon, Hugh, M.A. Oxon., 3, Courtfield-gardens, S.W.
Mar. 4, 1875		Gordon, J. G., Queen Anne's Mansions, Westminster, S.W.
Mar. 6, 1890		Gossling, Frank, B.Sc., Condebec, Park Side, Hampton Wick
Feb. 1, 1883		Gothard, Frederic, Bearwood House, Burton-on-Trent
Jan. 17, 1889		||Gott, B.S., B.A., Corinium, St. Mark's, Cheltenham
Feb. 6, 1879		Gough, Thomas, Rev., B.Sc. (Lond.), King Edward's School, Retford, Notts
June 16, 1887		Gover, Herbert J., 29, Piccadilly, Hanley, Staffordshire
Jan. 17, 1889		Gow, Robert J., Halebank-terrace, Ditton, Widnes
May 4, 1893		Gower, Alfred Roland, 39, Stafford-street, Barrow-in-Furness
Feb. 2, 1871	Trans.	||Gowland, William, 19, Beaumont-crescent, West Kensington

Date of Election.		
Feb. 3, 1887		Goyder, George A., Hawkins-road, Medindie, Adelaide, South Australia
June 19, 1884		Grace, W. F., 54, York-road, Hove, Brighton
Feb. 6, 1879		Gracey, Robert, Faircombe, The Barnfield, Exeter
Feb. 15, 1894		Grafton, Walter, 11, Grosvenor-road, Upton Park, Essex
April 15, 1880	Trans.	‖Graham, C. Colborne, care of Messrs. Blundell, Spence, and Co., Beverley-road, Hull
May 1, 1862	Trans.	‖Graham, Charles, D.Sc., 23, Euston-buildings, Gower-street Station, N.W.
Feb. 6, 1890		Grant, James, Moss View, St. Mary's-road, Moston, Manchester
June 16, 1887		Gravill, Edward D., F.R.M.S., 6, Addington-road, Stroud Green, N.
Dec. 7, 1882		Gray, George, Canterbury College, School of Agriculture, Lincoln, New Zealand
Dec. 15, 1892		Gray, Thomas, Andersonian-buildings, 204, George-street, Glasgow
Feb. 19, 1891		Greaves, Robert Bond, 77, Netheredge-road, Sheffield
Dec. 4, 1890		Green, Alfred H., Oaklands, Lowton St. Mary's, Newton-le-Willows
Feb. 5, 1885	Trans	‖Green, Arthur George, Atlas Works, Hackney Wick, E.
June 15, 1893		Green, Arthur Henry, 176, Lloyd-street, Greenheys, Manchester
June 16, 1887		Green, John Edward, F.I.C., A.R.S.M., 52, Claypath, Durham
Dec. 5, 1878		Green, Herbert, Hayle Mill, Maidstone
Dec. 5, 1878		Green, Lawrence, Lower Tovil, Maidstone
Dec. 3, 1885		Greene, William H., M.D., 204, North 36th-street, Philadelphia
April 2, 1874	Trans.	Greenaway, A. J., 39, Frognal, Hampstead, N.W.
June 4, 1885		Greenway, Thomas J., 8th Avenue, East Adelaide, South Australia
April 17, 1884		Greenish, Henry G., 20, New-street, Dorset-square, N.W.
May 18, 1871		Greenish, Thomas, F.R.M.S., 20, New-street, Dorset-square, N.W.
May 15, 1873		Greenwood, William Henry, Birmingham Small Arms and Metal Co., Adderley Park Works, Birmingham
June 18, 1891		Gregory, Alfred John, M.D., B.Sc., 20, Streatham-place, Streatham Hill, London, S.W.
May 7, 1885		Gregory, G. M., Ghazipur, N.W.P., India
April 21, 1887		Gregory, W., Steam Brewery, Dartford, Kent
Mar. 1, 1883		‖Grenfell, Claud, M.A., 29, Chester-square, S.W.
Mar. 5, 1874		Greville, Henry Leicester, Diersheim, Churchfields, Woodford, Essex
April 17, 1884		Grey, William J., 10, Tynevale-terrace, Gateshead
Dec. 7, 1893		Grieve, William Hatten, 226, Friern-road, East Dulwich, S.E.
Feb. 2, 1888		Griffith, D. Agnew, 41, Hamilton-square, Birkenhead
June 16, 1859		Griffith, George, M.A., College-road, Harrow

Date of Election.		
Dec. 15, 1881	Trans.	Griffiths, Arthur Bower, Ph.D., F.R.S.E., 12, Knowle-road, Brixton, S.E.
April 17, 1879		Griffiths, Thomas, The Cedars, Clapham Common, S.W.
Feb. 19, 1874	Trans	||Grimshaw, Harry, Gibbons-street Chemical Works, Bradford, Manchester
April 15, 1880		Grimwood, Robert, London County Council, Chemical and Gas Department, 40, Craven-street, W.C.
May 4, 1893		Grimwood, Robert George, 41, Lady Margaret-road, St. John's College Park, N.W.
Dec. 5, 1889		Gripper, Harold, 2, Heald-place, Rusholme, Manchester
Dec. 15, 1892		Gronow, William Thomas, Port Pirie Smelting Works, Port Pirie, South Australia
April 6, 1871	Trans.	||Groves, Charles Edward, F.R.S., Kennington-green, S.E.
Dec. 17, 1857		Groves, T. B., Weymouth
April 20, 1871		Grundy, Cuthbert Cartwright, F.L.S., South Shore, Blackpool, Lancashire
Jan. 17, 1889		Gudeman, Edward, Ph.D., P.O. Box 3001, New York City, U.S.A.
June 7, 1888		Guiterman, Albert L., Ph.D., 36, Primrose Hill-road, N.W.
Dec. 6, 1888		Guthrie, Frederick Bickell, Chemical Laboratory, The University, New South Wales
Nov. 4, 1875		Guyer, James Brett, Wrentham, Higher Erith-road, Torquay
June 4, 1874		Habirshaw, W. M., 159, Front-street, and 315, Madison-avenue, New York City, U.S.A.
Feb. 7, 1878		||Hadkinson, John, Teheran, Persia
Dec. 7, 1893		||Hadley, Henry Edwin, The School of Science, Kidderminster
Dec. 16, 1886	Trans.	Haga, T., No. 1, Sadowara-Cho, Tokyo, Japan
June 16, 1881		Hailes, Alfred James de, 2, Fisher-street, Red Lion-square
Dec. 15, 1892		Haines, Walter S., Prof., c/o Rush Medical College, Chicago, U.S.A.
Jan. 20, 1876	Trans.	Hake, H. Wilson, Ph.D., Westminster Hospital, S.W.
Dec. 7, 1893		Hale, Henry Ormsby, Oundle School, Northamptonshire
Dec. 3, 1891		Hall, A. D., 36, Poplar-grove, West Kensington Park, W.
Jan. 17, 1889		Hall, Allan T., Inglebank, Newlands, Hull
Dec. 3, 1891		Hall, Archibald, 34, Bishopsgate-street, E.C.
Mar. 3, 1887		Hall, Edgar, Albert-street, Brisbane, Queensland
April 4, 1889		Hall, James, B.A., B.Sc., Bancroft's School, Woodford, Essex
Dec. 1, 1887		Hall, J. C. August, c/o J. C. Hall, Esq., Poste Restante, Box 172, Durban, Natal, South Africa
Jan. 17, 1889		Hall, John A., 108, Lloyd-street, Greenheys, Manchester
May 3, 1866		||Hall, Marshall, Capt., Easterton Lodge, Parkstone, R.S.O., Dorset

Date of Election.		
June 1, 1876		Hall, Samuel, East London Soap Works, Bow
Dec. 18, 1884		Hall, Thomas P., M.A., Ph.D., Tabor, Iowa, U.S.A.
Feb. 16, 1893		Haller, Albin, 14, Rue de Metz, Nancy, France
May 20, 1886		Halliburton, William Dobinson, M.D. Lond., B.Sc. Lond., F.R.S., 9, Ridgmount-gardens, Gower-street, W.C.
Feb. 3, 1859		‖Hambly, C. H. Burbidge, Holmeside, Hazelwood, near Derby
April 17, 1890	Trans.	Hambly, Frederick J., University College, Dundee
June 7, 1888		Hamilton, James C., Trinity Lodge, Edinburgh
Feb. 15, 1894		Hamilton, Robert, 5, Lake-street, Hunslet, Leeds
May 6, 1875	Trans.	Hamlet, W. M., Government Laboratory, Macquarie-street, Sydney, N.S.W.
Dec. 7, 1882		Hammersley, W. A. Leslie, Bridge House, Leek, Staff.
Jan. 18, 1877		Hampton, William, 38, Lichfield-street, Hanley
Feb. 7, 1857		Hanbury, Cornelius, Plough-court, Lombard-street, E.C., and Dynevor House, Richmond, Surrey
June 15, 1893		Hancock, Ernest Albert, Government Laboratory, St. Kitts, Leeward Islands, W.I.
Mar. 7, 1872	Trans.	Hannay, James Ballantine, Cove Castle, Loch Long, N.B.
Feb. 21, 1889		‖Hanson, Alfred Miall, The Marjorie, Whalley, near Blackburn
Feb. 3, 1859	Trans.	‖Harcourt, A. Vernon, M.A., F.R.S., Cowley Grange, Oxford
April 16, 1863		‖Harcourt, L. F. Vernon, M.A., Fairholme, Weybridge
Mar. 17, 1887		‖Harden, Arthur, Ashville, Upper Chorlton-road, Manchester
May 7, 1885		Hards, William Benjamin, B.A. Lond., St. John's College, Battersea, S.W.
Dec. 15, 1892		Hardy, James G., 1, Keir-terrace, Pollokshields, Glasgow
Jan. 20, 1876		Hargreaves, James, Peel House-lane, Farnworth, near Widnes, Lancashire
June 19, 1884		Hargreaves, John, Widnes, Lancashire
Dec. 16, 1875		Harkness, William, Laboratory, Somerset-house, W.C.
June 1, 1876		Harland, R. H., 37, Lombard-street, E.C.
Feb. 7, 1878		‖Harland, William Dugdale, 48, King-street, Manchester
Mar. 2, 1857		‖Harley, George, M.D., F.R.S., 25, Harley-street, Cavendish-square, W.
Jan. 15, 1874		‖Harman, Frederick Edwin, M.R.A.C., care of Dr. Piggott, Orchard-gardens, Teignmouth, Devon
Dec. 15, 1881		Harrington, William Bury, Leeview, Montenotte, Cork
Feb. 21, 1884		Harris, Frank W., Laboratory, G.W. Ry., Swindon, Wilts
Dec. 7, 1893		Harris, Harold, Denmark House, Tufley-avenue, Gloucester
Dec. 17, 1874		Harris, Henry Penley, 15, Coverdale-road, Shepherd's Bush, W.
Dec. 2, 1886		Harris, Sydney Joseph, Leeds School of Science and Technology, Rossington-street, Leeds
Feb. 7, 1878		‖Harris, Thomas Frederick, B.Sc., Bromley Lodge, Bromley, Kent
May 17, 1888		Harrison, Albert, 72, Windsor-road, Forest Gate

Date of Election.		
Feb. 15, 1894	Trans.	Harrison, Edward Frank, 17, Bloomsbury-square, W.C.
June 21, 1883		‖Harrison, Hugh Erat, B.Sc., Leigh Chambers, Gt. Ormond-street, W.C., and Faraday House, Charing Cross-road
May 17, 1888		Harrison, J. Burchmere, Government Laboratory, British Guiana
Feb. 19, 1891		Harrold, Frederick W., 18, Maddox-street, W.
Feb. 17, 1876	Trans.	Harrow, G. H., Ph.D., 127, Station-street, Burton-on-Trent
Mar. 4, 1886		Hart, Bertram Harvey, The Elms, Old Charlton, Kent, S.E.
Jan. 21, 1869	Trans.	Hart, F. W., Esq., Holly House, 96, Stoke Newington-road, N.
Mar. 15, 1888		Hart, James, 131, Embden-street, Manchester
Dec. 6, 1883		Hart, Thomas, 166, Blackburn-road, Bolton
May 7, 1891		Hart, William Beaumont, Gransmoor Avenue, Fairfield, near Manchester
Mar. 16, 1882		Hartley, Arthur, Cannon Brewery, Brighton
Dec. 20, 1866	Trans.	Hartley, Walter Noel, Prof., F.R.S., Royal College of Science, Stephen's-green, Dublin ; and 36, Waterloo-road, Dublin
Feb. 6, 1890		Hartog, P. J., B.Sc., Owens College, Manchester, and 6, Greville-road, London, N.W.
Dec. 3, 1885		Harvey, Ernest W., A.R.S.M. Hilsrig, Alderbrook-road, Balham, S.W.
Feb. 17, 1881		Harvey, Sidney, Canterbury
Feb. 15, 1894		Harvey, W. Pellew, Portreath, Redruth, Cornwall, and Golden, British Columbia
Nov. 20, 1890		Haslam, Arthur R., Ph.D., Roseville, 39, Sydney-avenue, Blackrock, co. Dublin
May 6, 1875		Hastings, Henry Mitchell, 54, Edith-road, The Cedars, West Kensington
Feb. 18, 1892		Hatton, William Percy, care of W. R. Hatton and Sons, Wormwood Scrubs
Dec. 2, 1880		Hawkes, Alfred E., M.D. Bruss., L.R.C.P. Edin., 22, Abercromby-square, Liverpool
Feb. 2, 1888		Hawkins, Lewis Walter. 20 Norton Folgate, London, E.
Mar. 3 1887		Hay, Alexander, 97, Higher Ardwick, Manchester
April 15, 1880		Haydon, William Frederick, The Exchange, Birmingham
Feb. 15, 1894		Hayward, Edward Stanley, c/o Mrs. Sauders, 109, High-street, Crediton, Devon
Dec. 1, 1887		Head, C. James, F.I.C., care of W. L. Fransmith and Co., Ostrow Galodai, Uralskaja, Nos. 3, 4, 6, St. Petersburg, Russia
Dec. 15, 1881		Head, Harold Ellershaw, 24, Auriol-road, West Kensington, W.
Mar. 16, 1876		Head, Jeremiah, 47, Victoria-street. Westminster, S.W.
June 21, 1883		Heap, Hargreaves, Rev., B.Sc., The Grammar School, Rotherham, Yorks
Feb. 16, 1893		Heath, Arthur John, 1, Grove-villas, Redland, Bristol
Dec. 3, 1891		Heath, John William, 33, Upper Gloucester-place, W.
Mar. 3, 1887		Hedley, T. Albert, 41, Jean Baptiste-street, Montreal, Canada

Date of Election.		
Nov. 2, 1876		Hehner, Otto, 11, Billiter-square, E.C.
Dec. 4, 1890		Heller, William M., King's College School, Strand, W.C.
June 3, 1875		‖Hellon, Robert, Ph.D., Seascale, viâ Carnforth
Jan. 18, 1872		Helm, Henry James, Simonstone, Hammelton-road, Bromley, Kent
Dec. 5, 1889		Helbing, H. B., 63, Queen Victoria-street, E.C.
Feb. 5, 1885	Trans.	Henderson, George G., M.A., D.Sc., F.I.C., the Technical College, 204, George-street, Glasgow
Feb. 18, 1892		Hendrick, James, Young Laboratory, 60, John-street, Glasgow
April 19, 1883		Henning, E. C., The Bow Brewery, Bow, E.
Feb. 21, 1853		Hepburn, J. G., LL.B., Dartford, Kent
June 18, 1885		Hepworth, Thomas Cradock, 45, St. Augustine's-road, Camden-square, N.W.
Feb. 16, 1871		Herman, Douglas, Eccleston-park, Prescot
June 15, 1876	Trans.	Heron, John, care of Messrs. Garton, Hill, & Co., Southampton Wharf, Battersea, S.W.
Dec. 7, 1893		Hesketh, William, 16, New Market-street, Blackburn
May 5, 1892	Trans.	Hewett, John Theodore, St. John's College, Cambridge
Feb. 18, 1892		Hewlett, John C., 40, Charlotte-street, Great Eastern-street, London, E.C.
June 21, 1883	Trans.	‖Heycock, Charles T., M.A., 24, Fitzwilliam-street, Cambridge
Feb. 16, 1882		Heyes, J. F., Rev., M.A. Oxon., F.R.G.S., Magdalen College, and 36, Dynham-road, West Hampstead, N.W.
April 1, 1875		Heywood, Charles A., Ivy Bank, Cardiff
Dec. 1, 1864		Heywood, Henry, Cardiff
Dec. 1, 1887		‖Heywood, J. Garnett, 127, Sutherland-avenue, Maida Vale, W.
Feb. 6. 1890		Heywood, Joseph H., 23, Holland-street, Rochdale
April 3, 1848		Heywood, J. S. C., 19, Inverness-terrace, Kensington-gardens, W.
June 1, 1876	Trans.	Hibbert, Walter, 14, Goldhurst-terrace, South Hampstead, N.W.
Mar. 17, 1881		‖Hiddingh, Michael, Newlands, near Capetown
May 7, 1891		Hiepe, William L., Ph.D., The Laboratory, Kilvert's Buildings, Withy Grove, Manchester
March 16, 1882		‖Hill, Alexander, Campanas, 15, Cordova, Spain
Dec. 16, 1858		Hill, Alfred, M.D., F.I.C., Medical Officer of Health, The Council House, Birmingham
Feb. 15, 1894		‖Hills, Edmond Herbert, Captain R.E., Darland House, Chatham
Mar. 5, 1892		‖Hills, Harold F., 149, Bow-road, London, E.
May 15, 1873		‖Hills, Walter, 225, Oxford-street, W.
May 5, 1892		Hinnell, Henry Leonard, Messrs. Thwaite, Tozer and Co., Moorfields-chambers, 95 and 97, Finsbury-pavement, E.C.
Jan. 20, 1870		Hislop, G. R., Gasworks, Blackstoun-road, Paisley
Nov. 18, 1886		Hislop, Lawrence, Dalmeny, Saltney, Chester
June 21, 1883		‖Hobbs, Bedo, The Brewery, High-street, Maidenhead

Date of Election.		
Dec. 18, 1884		Hodges, Herbert J., Stoneleigh, Worple-road, Wimbledon
April 15, 1844	Trans.	Hodges, John F., Prof., M.D., F.I.C., J.P., Queen's College, Belfast, and Sandringham, Malone-road, Belfast
Nov. 16, 1882	Trans.	||Hodgkin, John, F.L.S., F.I.C., 12, Dynevor-road, Richmond-on-Thames
Dec. 18, 1879	Trans.	Hodgkinson, W. R. Eaton, Prof., Ph.D., F.R.S.E., 8, Park-villas, Blackheath, S.E.
April 15, 1886		Hodgson, Christopher, High House, Eppleby, Darlington
April 17, 1873		||Hodgson, H. Tylston, Harpenden, Herts
May 7, 1885		Hogg, Edward Grindle, 1, Southwick-street, Hyde Park-square, W.
Mar. 1, 1883		Hogg, W. Douglas, M.D., 62, Champs Elysées, Paris
April 17, 1890		Holburn, A., Cowan, B.Sc., 10, West-garden-street, Glasgow
June 11, 1876		Holcroft, Harold, M.A., Parkdale, Wolverhampton
Dec. 3, 1885		Holgate, Thomas, 12, Hyde Park-road, Halifax
Mar. 16, 1876		Holland, Philip, 27, Albert-road, Southport
Dec. 3, 1891		Holliday, John, The Gas Works, Scarboro'
Dec. 2, 1880		Holliday, Robert, Huddersfield
Feb. 15, 1894		Holmes, John Winder, 28, Crooms hill, Greenwich, S.E.
June 18, 1891		Holloman, Frederick R., 54, Russell-road, Custom House, E.
Mar. 4, 1886		Holloway, George Thomas, 57 and 58, Chancery-lane, W.C.
Dec. 2, 1886		Holt, George Crompton, Soap Manufacturers, Albion Works, Congleton, Cheshire
Dec. 7, 1893		Holthouse, H. B., 42, St. Ann's-valley, Nottingham
May 4, 1865		Holzmann, M., Ph.D., Marlborough-house, S.W.
Feb. 7, 1878		Hooker, A. H., Board of Health, Cairo, Egypt
Dec. 15, 1892		Hooker, Samuel C., The Franklin Sugar Refinery Co., 701, Front-street, Philadelphia
Mar. 1, 1883		||Hooper, David, Ootacamund, Madras Presidency, India
May 17, 1888		Hooper, E. Grant, 16, Royal-avenue, Chelsea, S.W.
Feb. 19, 1891		||Hooper, Ernest F., c/o Messrs. Burt, Boulton, and Haywood, Prince Regent's Wharf, Victoria Docks, E.
May 7, 1885		Hope, Charles Frederick, Prof., M.R.A.C., Lindesforne, Weymouth
Feb. 3, 1887		Hori, E., Tokyo Hygiene Laboratory, Kanda Ku, Tokyo, Japan
Feb. 15, 1894		||Hornby, R., B.A., The High School, Newcastle, Staffordshire
Dec. 15, 1892		Horsfall, John, Plantation House, Cloughfold, Manchester
Dec. 15, 1892		Horwill, Edgar E. C., Firs Villa, Fitzwilliam-road, Clapham, S.W.
Mar. 4, 1886		||Hoskins, Arthur Percy, 25, Cromwell-road, Belfast
Dec. 7, 1882		Hotblack, Herbert A., Cannon Brewery, Brighton
Feb. 16, 1871		Houlder, W. W., 10, Ossulton-villas, Southall-green, Southall
Mar. 17, 1887	Proc.	Houlding, William, B.Sc., Stanley House, Anfield, Liverpool
Dec. 7, 1882		||Howard, Alfred G., Holmbury, Woodford-green, Essex

Date of Election.		
Feb. 18, 1869		Howard, Alfred Kingsby, Bryntirion, Rhyl, North Wales
Nov. 3, 1870	Trans.	||Howard, David, Devon House, Buckhurst Hill, Essex
April 21, 1887		||Howard, D. Lloyd, jun., Alton Lodge, Woodford-green, Essex
Dec. 18, 1879		Howard, John, 22, Ashby-road, Canonbury
Mar. 4, 1875		Howard, Thomas, 50, Ellington-street, Liverpool-road, N.
June 20, 1889		Howard, George William, 49, Pier-road, Erith, Kent
Dec. 7, 1882		Howe, J. Lewis, M.D., Ph.D., Scientist to the Polytechnic Society, Louisville, Kentucky, U.S.A.
Feb. 19, 1880		Howell, Reginald, 95A, Southwark-street, S.E.
Jan. 20, 1876		Howie, W. L., Cornbrook House, Clarendon-road, Eccles, Lancashire
Jun. 15, 1893		Howitt, James J., Messrs. Bowman, Thomson and Co., Northwich
April 4, 1889		||Hoyle, Richard Ashworth, 11, Market-square, Lytham, Lancs.
April 4, 1889		Hoyles, Henry Richardson, care of Messrs. Treacher and Co., Byculla, Bombay, and Fern-place, 142, Upperthorpe, Sheffield
Mar. 2, 1871		||Hudleston, W. H., M.A., F.G.S., 8, Stanhope Gardens, South Kensington, S.W.
Feb. 21, 1878		Hudson, William, B.Sc. (Lond.), The Lilies, Twickenham
Feb. 15, 1894		Hughes, Frank, 27, Fairfied-road, Chelmsford
Feb 23, 1841		*Hughes, F. R., Bo'ness, Linlithgowshire
June 17, 1880		Hughes, George Henry, Analytical Laboratory, Barbadoes, West Indies; and 79, Mark-lane, E.C.
Dec. 17, 1868		Hughes, John, Analytical Laboratory, 79, Mark-lane, E.C.
May 17, 1888		Hughes, John, 16, Finsbury-circus, E.C.
Dec. 5, 1889	Trans.	Hughes, Robert Edward, B.Sc. (Lond.), B.A., B.Sc., Kelvin House, Blackwater-road, Eastbourne, and The College, Eastbourne
June 4, 1885		Hughes, T. Vaughan, Greenfield Mills, Holywell, North Wales
Nov. 16, 1882		Hughes, Thomas, Borough Analyst, West Wharf, Cardiff; Laboratory, 31, London-square, Cardiff
Nov. 20, 1884		Hulme, James, Newton Chemical Works, Hyde, Manchester
April 19, 1883		Humphrys, Norton H., 4, The Paragon, Wilton-road, Salisbury
Dec. 18, 1879	Trans.	Hummel, J. J., 7, Moorfield-villas, Woodsley-road, Leeds
Dec. 7, 1893		Hunt, Bertram, P.O., Box 1606, Denver, Colorado, U.S.A.
Mar. 18, 1869		Hunt, Charles, Birmingham Gas Light Works, Windsor-street, Birmingham
Feb. 1, 1883		Hunter, John, Minto House, Medical School, Edinburgh
Dec. 3, 1885		Hunter, Matthew, M.A. Oxon, Rangoon College, Lower Burmah
April 4, 1878	Trans.	Huntington, A. K., Prof., Metallurgical Laboratory, King's College, W.C.
Feb. 16, 1893		Huntly, George Nevill, 56, Sheen-road, Richmond, Surrey
Dec. 3, 1885		Hurst, George H., 22, Blackfriars-street, Salford
Mar. 21, 1861		Huskisson, H. O., 5, Gordon-square, London, W.C.

Date of Election.		
Feb. 15, 1894		Hutchinson, Alfred, The Leys, Cambridge
Feb. 6, 1890	Trans.	Hutchinson, Arthur, Pembroke College, Cambridge, M.A., Ph.D.
Jan. 17, 1884		Hutchinson, C. Clark, 193, Romford-road, Stratford, E.
April 19, 1888		Idris, Thomas Howell Williams, Pratt-street, Camden Town, N.W.
Feb. 7, 1867		‖Ince, Joseph, 11, St. Stephen's-avenue, Shepherd's-bush, W.
Dec. 15, 1892	Proc.	Ince, Walter H., Ph.D., Chemical Laboratory, St. Thomas' Hospital Medical School, S.E.
April 4, 1889	Proc.	Ingle, Herbert, Poole, near Leeds
Jan. 19, 1882		Irons, Herbert E. J., Chatham, New Brunswick, Canada, and Hapenden, St. Albans
Dec. 7, 1871		Irvine, Robert, Royston, Granton, near Edinburgh
Dec. 6, 1883		‖Irwin, Wilfred, 3, Wilton Polygon, Cheetham Hill, Manchester
Dec. 15, 1892		‖Isaac, John F. V., 18, Montserrat-road, Putney, S.W.
Feb. 16, 1882		Isherwood, Thomas, B.A., University School, Southport
Nov. 19, 1885		Ivatt, Albert, B.A., 21, Willis-road, Cambridge
Feb. 1, 1883		Jackson, Alfred H., B.Sc., Prof., c/o Wm. Bowen and Co., Collins-street, W., Melbourne, Australia
Feb. 15, 1894		Jackson, David Hamilton, M.A., B.Sc., Royal College of Science, South Kensington
Dec. 7, 1882		Jackson, Edward, 27, Beaufort-road, Edgbaston, Birmingham
Dec. 5, 1889		‖Jackson, Eric H., B.Sc., 61, Portland-street, Manchester
Dec. 18, 1884	Trans.	Jackson, Herbert, 3, Amyand Park Gardens, East Twickenham
Dec. 15, 1892		Jackson, John, Rhymney, near Cardiff
Dec. 4, 1890		Jackson, John Richard, 8, Broomhall-terrace West, Partick, Glasgow
Dec. 15, 1881		Jackson, Wm., F.G.S., 61, Beaconsfield-terrace, Northampton
Mar. 6, 1890		Jackson, John Charles, M.R.C.S., L.R.C.P., 2, Fulham Park-villas, Fulham, S.W.
Dec. 6, 1883		Jackson, Robert, 18, Harrington-street, Dublin
Dec. 15, 1884		‖Jackson, R. Valentine, Ph.D., care of the Scotch and Irish Oxygen Company, Polmadie, Glasgow
Dec. 15, 1892		Jackson, Samuel, 7, Mulgrave-terrace, Dalton, Huddersfield
June 16, 1887		‖Jadhava, K. B., Baroda, Bombay Presidency, India
May 16, 1878		Jago, William, F.I.C., 32, Clarendon-villas, Brighton
Feb. 18, 1888	Trans.	‖James, Christopher, care of Elliott's Metal Company, Pembrey Copper Works, R.S.O., Bury Port, South Wales
Feb. 17, 1881	Trans.	James, J. William, Ph.D., 29, Redcliffe-street, Bristol
Feb. 7, 1878		Jamieson, Alexander, 5, St. Mark's-crescent, Regent's Park, N.W.
Feb. 6, 1879	Trans.	†‖Japp, F. R., M.A., LL.D., Ph.D., F.R.S., University Aberdeen

† Longstaff Medallist, 1891.

Date of Election.		
Feb. 15, 1894		Jardine, Walter, 86, Victoria-place, Perth
Nov. 16, 1882		J'armay, Gustav, Hartford Lodge, Hartford, Cheshire
Feb. 19, 1891		Jenkins, Henry Charles, 33, Allenby-road, Forest Hill, S.E.
Nov. 20, 1890		Jenkins, Wallis, 9, Arnold-street, Aulaby-street, Hull
May 5, 1887		‖Jenkins, John H. B., Chemical Laboratory, G. E. Ry. Works, Stratford, E.
Feb. 15, 1894		Jenks, R. Leonard, Esq., 68, Victoria-road, Clapham, S.W.
Feb. 1, 1883		Jenner, Thomas, Leborah, Porchester
Feb. 15, 1894		Jennison, Francis Herbert, c/o A. Dollingworth, Esq., Moscow, Russia
April 17, 1879		Jewson, Francis A. B., 11, Kenwyn-road, High-street, Clapham
Feb. 4, 1875		‖Johnson, David, F.G.S., F.R.M.S., 11, Thurlow-terrace, Larkhill-rise, Clapham, S.W.
Dec. 18, 1884		‖Johnson, Frank, Thariss, Huelva, Spain
Feb. 21, 1878	Trans.	Johnson, George Stillingfleet, 11, Savile-row, W.
Feb. 1, 1883		Johnson, James Edward, 40, Edmiston-road, Stratford, E.
May 16, 1872		Johnson, John Grove, 41, Cross-street, Finsbury, E.C.
May 20, 1886		Johnson, J. T., Oakham School, Rutland
Dec. 6, 1883		Johnson, Samuel, 174, Queen's-road, Everton, Liverpool
May 10, 1866		‖Johnson, Samuel H., Warren Hill House, Loughton, Essex
Dec. 18, 1884		Johnstone, James D., Moss Bank, Fettercairn, Lawrence-kirk, N.B.
April 17, 1879		Johnstone, William, Ph.D., Elfingham House, Arundel-street, Strand, W.C.
Dec. 15, 1892		Johnston, William George, c/o Messrs. Warwick's, The Brewery, Newark-on-Trent
May 20, 1886		Jones, A. Wentworth, M.A. Oxon, The Currie Schools, Folkestone
April 6, 1871	Trans.	Jones, E. W. T., The Oaklands, Wolverhampton; and 10, Victoria-street, Wolverhampton
Dec. 4, 1873	Trans.	Jones, Francis, F.R.S.E., Beaufort House, Alexandra Park, Manchester
May 4, 1876	Trans.	‖Jones, H. Chapman, Royal College of Science, South Kensington, S.W.
May 4, 1893		Jones, Hedley Gordon, 14, Connaught-road, Kensington, Liverpool
May 16, 1878		Jones, Henry Williams, 17, White-street, Coventry
May 15, 1890		Jones, John Archyll, 26, Baker-street, Middlesborough
Feb. 19, 1891		Jones, M. William, 50, Mayfield-road, Whalley Range, Manchester
Feb. 18, 1892		Jones, Lionel Manfred, St. Dunstan's College, Catford, S.E.
May 7, 1891		Joseland, Walter Herbert, Mitchell's Wood Cottage, near Chesterton, Staffordshire
May 4, 1893	Trans.	Jowett, Hooper A. D., B.Sc., 17, Bloomsbury-square, W.C.
Feb. 21, 1891		Jowett, William Hall, 2, Mayfield-road, Aigburth, near Liverpool

Date of Election.		
Dec. 15, 1892		Kacker Kunwar, K., 22, Leinster-gardens, Lancaster-gate, W.
May 4, 1893		Káká Sorabji, Manekji, Devon Villa, Karachi, Sind, India
Dec. 16, 1886	Trans.	Kawakita, Michitada, Engineering College, Tokyo, Japan
Feb. 17, 1881	Trans.	Kay, William E., Gowansbank, Busby, near Glasgow
June 2, 1856		Kay, William, Rev., B.A., 114, Mount-street, Grosvenor-square, W.
Dec. 5, 1889		Kaye, James R., M.D., Medical Officer of Health, Town Hall, Huddersfield
Dec. 20, 1883		‖Keeling, Frank, Dapdune Cottage, Guildford
Dec. 7, 1882		Keen, Austin, Sunny Bank Villas, Edgerton, Huddersfield
Mar. 19, 1874		Kellner, William, Ph.D., Chemical Department, Royal Arsenal, Woolwich, S.E.
April 1867		‖Kemp, David Skinner, Missenden Villa, Coverdale-road, Shepherd's Bush, W.
May 4, 1882		Kemp, William Joel, Mountfield, Robertsbridge, Sussex
Dec. 18, 1884		Kendall, George Frederic, B.A., The Hollies, Stratford-upon-Avon
Dec. 17, 1874		Kendall, James Alfred, 3, Ashlake-road, Streatham, S.W.
Dec. 5, 1889		Kenwood, Henry R., M.B., C.M. (Edin.), L.R.C.P. (Lond.), 189, Adelaide-road, N.W.
Dec. 20, 1883		Kerry, William H. R., Wheatlands, Windermere
April 15, 1875		Keyworth, George Alexander, St. Hilary, Hastings
Dec. 7, 1882		Kilner, Frederick James, Royal Infirmary, Bristol
April 15, 1886		Kilpatrick, Charles, Laboratory, Health Office, Holt Town Depôt, Manchester
Jan. 17, 1884		Kilpatrick, W. Stirling, 4, Annfield-place, Glasgow
Feb. 15, 1872	Trans.	‖Kinch, Edward, Royal Agricultural College, Cirencester
Feb. 17, 1881	Trans.	King, Alfred John, Ingersley Vale, Bollington, near Macclesfield
Mar. 15, 1888		King, C. Millard, 21, Godliman-street, E.C.
Dec. 7, 1876		King, J. F., Laboratory of City Analyst, Edinburgh
Dec. 5, 1872	Trans.	Kingzett, Charles T., Elmstead Knoll, Chislehurst, Kent
Mar. 1, 1877		Kinninmont, Alex., 21, Abbotsford-place, Glasgow
May 7. 1891	Trans.	‖Kipping, F. Stanley, Ph.D., D.Sc. (Lond.), 7, Milburne-grove, South Kensington
Dec. 2, 1886		Kirby, Herbert E., 307, High Holborn, W.C.
May 15, 1890		Kirk, Oliver, Blaemire, Greysouthen, viâ Carlisle
Feb. 2 1888	Trans.	Kirkland, J. Booth, Princes-hill, Carlton, Melbourne, Victoria
May 17, 1888		Kirkman, Henry James, Landore, Alkali Works, Swansea
June 19, 1873		‖Kitchin, Archibald, F.I.C., Scragill House, Whitehaven
May 16, 1889		Kitchin, John, The Middlesex Hospital, W.C.
Dec. 6, 1888		‖Knaggs, Alfred Battye, Springfield Mill, Morley, near Leeds
Mar. 5, 1885		Knight, Alfred Henry, 34, Bentley-road, Prince's-park, Liverpool
June 20, 1889		Knight, Frederick Charles, Boston and Colorado Smelting Company, Argo, Colorado, U.S.A.

Date of Election.		
May 16, 1878		Knights, James West, County Laboratory, Cambridge
Dec. 5, 1889		Knott, Frederick Thomas, The Laurels, Eltham-road, Lee, S.E.
June 18, 1891		Knowles, John, Messrs. Bowman, Thompson and Co., Lostock, Gralam, near Northwich
Dec. 18, 1879		Knowles, Joshua, Stormer-hill, Tottington, Bury
Dec. 15, 1892		Knowles, Thomas Torrens, 23, Croxteth-grove, Sefton Park, Liverpool
June 16, 1864		Knox, G. W., B.Sc., 16, Finsbury-circus, London, E.C.
Feb. 6, 1873		Koch, Walter Edward, M.A., F.G.S., Sharpsburg, Allegheny County, Pennsylvania
Nov. 17, 1887		Koga, Yoshimasa, The Imperial Mint, Osaka, Japan
June 17, 1886		Kohn, Charlers A., Ph.D., B.Sc., Chemical Laboratory, University College, Brownlow-street, Liverpool
June 8, 1885		Koningh, Leonard de, 325, Kennington-road, S.E.
Dec. 15, 1892		Krause, Dr. G., Cothen, Germany
Feb. 17, 1859	Trans.	Kynaston, Josiah W., Chemical Laboratory, 3, Oak-terrace, Beech-street, Liverpool
Feb. 3, 1859		||Lackersteen, Mark Henry, M.D., M.R.C.P. Lond., M.R.C.S. Eng., F.L.S., Medical School, and 163, State-street, Chicago, Illinois, U.S.A.
Feb. 16, 1888		Lafosse, Charles R., Abbotsford, Wildercombe Park, Ilfracombe
May 4, 1893		Lamb, Edmund George, M.A., 29, Great Cumberland-place, W.
Dec. 15, 1892		||Lamb, Thornton Charles, The Polygon, Ardwick, Manchester
Feb. 16, 1893		Lambert, Wesley, 55, Plumstead Common-road, Plumstead, S.E.
Jan. 18, 1877		Lancaster, William James, F.R.A.S., F.R.C.S., F.R.M.S., The Hollies, Handsworth Wood, Birmingham
Mar. 4, 1886		Lang, William, Cross Park, Partick, N.B.
June 18, 1885		Langer, Charles, Ph.D., Eaton House, Willes-road, Leamington
May 7, 1891		||Langham, Rev. E. Norman, M.A. (Cantab), F.L.S., Head Master, Rastrick Grammar School, Brighouse
June 21, 1877	Trans.	Lapraik, William, Ph.D., F.I.C., 18, Dagmar-road, Camberwell, S.E.
Feb. 16, 1894		Lapworth, Arthur, 13, Duchess-road, Edgbaston, Birmingham, and 9, Spencer-road, Putney, S.W.
June 21, 1883		Lascelles, B. P., B.A., Harrow
April 15, 1880		Last, Frank B., Laboratory, 78, Mansell-terrace, Swansea
May 7, 1891		Lauder, Alexander, University College of North Wales, Bangor
Feb. 21, 1889		Lauer, Wm. Eggleston, 657 and 659, Broadway, New York City
Mar. 4, 1886	Trans.	Laurie, Arthur P., 49, Beaumont-square, Mile End, E.
Nov. 16, 1876		||Law, Channell, Ilsham Dene, Torquay
Feb. 6, 1890		Law, Robert, F.R.M.S., The Royal Mint, Melbourne
June 17, 1850	Trans.	||Lawes, Sir John Bennet, F.R.S., Rothamsted, near St. Albans
June 17, 1880	Trans.	Lawrance, Henry Awbrey, 28, Grosvenor-road, Gunnersbury, W.

Date of Election.		
Jan. 19, 1882		Laws, J. Parry, 3, Fyfield-road, Oxford
Feb. 2, 1888	Trans.	||Lawson, Thomas Atkinson, Ph.D., B.Sc., 15, Alexandra-road, N.W.
April 17, 1890		||Laycock, William Frederick, Ph.D., 2, Park-street, Dewsbury
April 17, 1890		Lea, A. Sheridan, D.Sc., F.R.S., Caius College, Cambridge
Dec. 16, 1886		||Leach, Walter, 27, St. Andrew's-place, Bradford
April 4, 1889		Leaper, Clement Joseph, 19, Belvidere-road, Taunton, Somerset
Feb. 2, 1888		Lease, Frank E., Melapi Estate, Sandakan, British North Borneo
Dec. 3, 1891		Leather, J. Walter, Ph.D., Dehra Dun, N.W.P., India
Dec. 5, 1889		Ledingham, L. Napier, Longley Farm, Longley, near Sheffield
Dec. 6, 1883		Lee, Herbert C., The New Westminster Brewery Company, Earl-street, Horseferry-road, S.W.
Feb. 1, 1883		Lee, Robert Brewer, B.Sc., B.A., 6, Warwick-street, Kensington, W.
June 18, 1891		Leeds, Frank H., 26, East Bank, Stamford-hill, N.
Mar. 1, 1883		Leeming, T. H., Burneston House, Barking-road, Plaistow, Essex
Feb. 6, 1873		Lees, Charles, Grange College, Leominster
Dec. 1, 1887		Lees, Samuel, jun., Park Bridge, Ashton-under-Lyne
Dec. 3, 1891		Leffler, Rudolf, 21, Havelock-street, Sheffield
May 16, 1889		||Legg, John Edmund, M.A., F.I.C., Weymouth College, Ing Ravan, Carlton-road, Weymouth
May 7, 1891		Leicester, James, 8, Richmond-terrace, Clifton, Bristol
Jan. 17, 1889		Leigh, Cecil, Birmingham Small Arms and Metal Company, Adderley Park Rolling Mills, Birmingham
Dec. 1, 1887		Lennox, David, M.D., 144, Nethergate, Dundee
Dec. 3, 1891		Lennox, Robert N., 3, Inverness-terrace, Fulham, S.W.
Jan. 17, 1889		Lenox, Lionel R., Ph.B., Leland Stamford University, Palo Alto, Santa Clara County, California
June 17, 1886		Leon, John Temple, 38, Portland-place, W.
Feb. 15, 1894		Leonard, Norman, B.Sc., 2, Lorne-road, Brixton, S.W.
Jan. 19, 1882		Lescher, Frank Harwood, 60, Bartholomew-close, E.C., and 31, Devonshire-place, W.
April 17, 1890		Lescher, Herman, 61, Egerton-gardens, South Kensington
Feb. 6, 1879	Trans.	Letts, Edmund Albert, Ph.D., Queen's College, Belfast
Mar. 15, 1888	Trans.	Lewes, Vivian B., 19, Park-row, Greenwich, S.E.
Mar. 20, 1884		Lewis, A. E., 94, Tritonville-road, Sandymount, Dublin
Nov. 18, 1869	Trans	||Lewis, W. J., Mineralogical Museum, Cambridge
Feb. 16, 1888	Trans.	Lewkowitsch, Julius, Ph.D., Whitehall Soap Works, Leeds
Feb. 21, 1878		Lichtenstein, T., Chemical Works, Silvertown, E.
April 15, 1880	Trans.	Liepmann, Henry, Ph.D., Chemical Laboratory, 40, Lexham-gardens
June 21, 1866		Lightbown, J. H., 13, Victoria-crescent, Eccles, near Manchester
May 5, 1892		Lindley, Hubert Edward, 22, Charteres-road, Finsbury-park, N.
Mar. 5, 1874		Linford, J. S., 16, Gladstone-street, Anlaby-road, Hull

Date of Election.		
April 15, 1886	Proc.	Ling, Arthur R., Carlton Villas, Lambton-road, Cottenham Park, Wimbledon
Feb. 7, 1878		Linnell, Arthur, New Cransley Iron and Steel Co., Kettering
May 5, 1892		Lintern, Albert A., B.Sc., Kendrick School, Reading
Nov. 21, 1853	Trans.	‖Liveing, G. D., M.A., Cambridge
Nov. 7, 1872		‖Liversidge, Archibald, F.R.S., Prof., University, Sydney, New South Wales
June 21, 1883		Livingston, W. J., London County Council, Spring-gardens, S.W
Feb. 19, 1880	Trans.	‖Lloyd, Alfred, The Dome, Bognor, Sussex
Feb. 3, 1876	Proc.	Lloyd, F. J., Agricultural Laboratory, 4, Lombard-court, E.C.
May 4, 1893		Lloyd, Herbert, The Electric Storage Battery Co., Drexel Building, Philadelphia, U.S.A.
Feb. 16, 1871		Lockyer, William John, 7, St. Julian's Farm-road, West Norwood, S.E.
Mar. 20, 1884		Lendon, J. Edward, M.D., 62, Main-street, George Town, Demerara
April 18, 1872		‖Longstaff, George Blundell, M.A., M.B. Oxon., M.R.C.P., Highlands, Putney Heath, S.W.
Dec. 15, 1881		‖Looker, Percy Stratford
Feb. 20, 1873	Trans.	Loram, H. Y., 19, Hillside-road, Stamford-hill, N.
Feb. 7, 1878		‖Louis, D. A., 77, Shirland-gardens, Maida Vale, W.
May 4, 1882		Love, Edward G., Ph.D., 80, East 55th-street, New York, U.S.A.
June 15, 1882		‖Lovibond, Thomas Watson, F.I.C., The Tyne Brewery, Newcastle-on-Tyne
Dec. 18, 1884		Low, Charles William, M.B., Stowmarket
Dec. 15, 1856		‖Lowe, Charles, Summerfield House, Reddish, near Stockport
Feb. 21, 1878		‖Lowe, Walter Bezant, M.A., Stranraer School, Wickham, near Fareham, Hants
Feb. 3, 1876		Lowe, W. F., A.R.S.M., 9, Hough-green, Chester
Dec. 6, 1888		Lowman, Oscar A. B., Ph.D., 424, Brush-street, Detroit, Michigan, U.S.A.
Feb. 15, 1894		Lucas, E. W., 6, Chelsea-gardens, S.W.
Feb. 18, 1892		Luckett, A. H., The Palace School, Endfield, Middlesex
Dec. 3, 1891		Ludlow, Lionel, The Cape Copper Co., O'okiep, Namaqua-land, Cape of Good Hope
Feb. 15, 1877	Trans.	Luff, A. P., M.D., B.Sc. (Lond.), 31, Weymouth-street, Cavendish-square, W.
Mar. 6, 1890		Lumsden, John S., B.Sc., Chemical Laboratory, Arciss Strasse No. 2, München, Germany
Dec. 5, 1867	Trans.	Lunge, Dr. George, Polytechnicum, Zürich, Switzerland
Dec. 4, 1890	Trans.	Lunt, Joseph, B.Sc., 5, South-view, Eccleston-road, Ealing Dean, W.
Dec. 5, 1872	Trans.	‖Lupton, Sydney, Grove Cottage, Roundhay, Leeds
Feb. 30, 1894		Luty, Arthur, 80, Bryn-y-Mor-terrace, Swansea

Date of Election.		
Feb. 16, 1893	Proc.	Luxmoore, Charles M., B.Sc., Casseldon-road, Willesden, N.W.
May 1, 1873		Lyon, J. B., Brigade Surgeon, East India, U. S. Club, 16, St. James's-square, S.W.
Feb. 19, 1874		Lyon, J. G., The Aire Tar Works, Knottingley, Yorks
Nov. 18, 1886	Trans.	Lyons, Albert Brown, A.M., M.D., Honolulu, Hawaiian Islands
Feb. 3, 1859		||Lyte, F. Maxwell, F.I.C., Assoc. I.C.E., 60, Finborough road, Kensington, S.W.
Feb. 16, 1888		Maben, Thomas, 5, Oliver-place, Hawick
June 20, 1878		Macadam, C. T., The Lake, Snaresbrook, Essex
April 21, 1864	Trans.	||Mactear, James, F.R.S.E., 2, Victoria-mansions, Westminster S.W.
Feb. 21, 1853		Macadam, Stevenson, Ph.D., F.R.S.E., Surgeons' Hall, Edinburgh
Feb. 2, 1888		||Macadam, Stevenson, J.C.G., jun., Surgeons' Hall, Edinburgh
April 4, 1878		Macadam, W. Ivison, F.R.S.E., Professor New Veterinary College, Surgeons' Hall, Edinburgh
Dec. 2, 1886		Macan, Hugh, M.A., County Hall, Kingston-on-Thames
April 17, 1890		||MacArthur, J. Stewart, 12, Knowe-terrace, Pollokshields, Glasgow
Feb. 15, 1894		Macdonald, A. H., The Green, Marlborough, Wilts
May 7, 1891		MacDonald, William, Tung Wen Kwan, Imperial College, Peking
Mar. 4, 1886		MacEwan, Peter, 4, Gresley-road, Hornsey-lane, N.
June 18, 1891		Macfie, R. A. Scott, B.A. (Cantab), 68, Rodney-street, Liverpool
Dec. 2, 1880		Macfarlane, James A., care of Mr. Robert Stevenson, 917, Vender-street, Vancouver City, British Columbia
Mar. 6, 1890		Macintyre, Alfred E., St. John's, N.B., Canada
June 17, 1875		Mac Ivor, R. W. Emerson, c/o Hannay's Patents Company, 67, Great Clyde-street, Glasgow
Dec. 2, 1887		Mackay, Angus, Technical College, Ultimo, Sydney, N.S.W.
Dec. 2, 1886		Mackay, J. B., Lillie Prof. A.K.C.L., Director of the School of Mines, Sandhurst, Victoria, Australia
Dec. 4, 1890		Mackean, William, 14, Palmer-street, Westminster, S.W.
Dec. 3, 1874		Mackenzie, D. C., 106, Leadenhall-street, E.C.
Feb. 18, 1892		Mackenzie, William Cossar, Tewfikieh College of Agriculture, Ghizeh, Cairo
Mar. 5, 1885		Mackey, Wm. McD., Victoria-chambers, South-parade, Leeds
Jan. 15, 1844		Maclagan, Douglas, Sir, M.D., F.R.S.E., University of Edinburgh, and 28, Heriot-row, Edinburgh
Jan. 17, 1889		MacLeroy, Arthur Lloyd, M.A. (Oxon), L.S.A., 12, George-street, Bathwick Hill, Bath
April 17, 1879		Macmillan, J. L., 1, Mangoe-lane, Calcutta
Feb. 17, 1881		MacMunn, Charles A., M.A., M.D., F.R.M.S., Oakleigh Wolverhampton

Date of Election.		
Feb. 1, 1880		Macnab, William, 14, Great Smith-street, Westminster, S.W.
June 4, 1885		Macnair, Duncan Scott, Ph.D., B.Sc., 2, Grosvenor-terrace, Hillhead, Glasgow
April 19, 1888		MacSwiney, E., 13, North Main-street, Cork
Feb. 6, 1890		Mactaggart, James Guthrie, care of Messrs. Boarhead and Co., Singapore
May 1, 1862	Trans.	Madan, H. G., Bearland House, Gloucester
June 21, 1888	Trans.	Maiden, Joseph Henry, Curator, Technological Museum, Sydney, N.S.W.
May 5, 1892		Major, George Harry, Higher Grade Boys' School, Llanelly
May 7, 1885		‖Mallet, F. R., 18, The Common, Ealing, W.
Dec. 17, 1857	Trans.	Mallet, J. W., Ph.D., M.D., F.R.S., University of Virginia, Albemarle, Co. Va., U.S.N.A.
Feb. 4, 1858		‖Manning, F. A., 18, Billiter-street, E.C.
Feb. 7, 1853	Trans.	Marcet, W., M.D., F.R.S., Flowermead, Wimbledon Park, S.W.
Feb. 16, 1893		Marsden, Fred, Ph.D., Bangor, North Wales
June 16, 1881		‖Marsh, Charles W., Ph.D., 126, Liberty-street, New York, U.S.A.
Feb. 15, 1883	Trans.	Marsh, J. E., University Museum, Oxford
Feb. 6, 1890	Trans.	Marshall, Hugh, D.Sc., F.R.S.E., Chemical Department, University of Edinburgh
Dec. 3, 1891		Marshall, John Willis, 8, Fairfield-terrace, West Park-street, Dewsbury
Feb. 19, 1891		Marshall, Reginald Tom, 25, Lancaster-park, Richmond, Surrey
Nov. 20, 1890		Marshall, T. Rhymer, D.Sc., Chemical Laboratory, St. Mungo's College, Glasgow
Dec. 6, 1888	Trans.	Marshall, William, c/o D. G. Rose, Esq., Samarang, Java
June 16, 1887		Marshall, William, F.I.C., 15, West-street, Rochdale
June 15, 1893		Martin, Alexander Mitchell, Douglas-villa, Dunbeth-road, Coatbridge
Nov. 19, 1885		Martin, Major Gerald Ward, F.R.G.S., Assay Office, Imperial Mint, Bombay
Dec. 6, 1883		Martin, W. H., 183, King's-road, Chelsea, S.W.
Feb. 16, 1893		Martin, William J., jun., M.D., University of Virginia, Charlottesville, Va, U.S., N.A.
Feb. 19, 1891		Martin, William Morley, 16, Penryn-street, Redruth, Cornwall
April 7, 1870		Martindale, William, 10, New Cavendish-street, W.
June 1, 1871		‖Martineau, George, 21, Mincing-lane, E.C.
Dec. 1 1887		‖Martineau, Sydney, South-road, Clapham-park, S.W.
June 2, 1851	Trans.	Maskelyne, Nevil Story, F.R.S., Salthrop, Wroughton, Wilts
Mar. 2, 1871		Mason, Alfred Henry, F.R.M.S., Seabury Building, 59, Maiden-lane, New York City, U.S.A.
May 4, 1893		Mason, James, Cambois, Blyth, Northumberland
Nov. 4, 1858		‖Mason, James, Eynsham-hall, near Witney, Oxon

Date of Election.		
Dec. 2, 1880		Mason, William Brandwood, 117, Derby-street, Bolton
Dec. 5, 1889		Mason, James Braik, 9, Balgay Avenue, Dundee
Feb. 6, 1890		Mason, Francis H., The Assay Office, Arlington-place, Truro, Nova Scotia
Dec. 5, 1889		Mason, G. B., 7, Upper Chadwell-street, Myddleton-square, E.C.
Jan. 19, 1882	Trans.	Masson, D. Orme, M.A., B.Sc., The University, Melbourne, Australia
Dec. 4, 1873		Masters, William, Sub-Deputy Opium Agent, Gya, Bengal, India, and 82, Oxford-gardens, Notting Hill, W.
June 15, 1876	Trans.	‖Matthews, C. G., The Laboratory, Bridge Chambers, Burton-on-Trent
June 17, 1880	Trans.	Matthews, Francis Edward, Ph.D., Royal Indian Engineering College, Cooper's Hill, Staines
Dec. 1, 1887		Matthews, Wm. Edward, Prof., The Stawell School of Mines, Stawell, Victoria, Australia
Jan. 17, 1884		‖Matthey, Edward, 78, Hatton-garden, E.C.
May 3, 1870		Matthey, George, F.R.S., 78, Hatton-garden, E.C.
Dec. 7, 1893		‖Mawer, William Frederick, 16, Fentiman-road, S.W.
Dec. 7, 1865		‖Maxwell, Theodore, B.A., M.D. Camb., B.Sc. Lond., 29, Woolwich-common, S.E.
Dec. 5, 1867		Maybury, Charles Walter, 141, Church-street, Eccles, Lancashire
June 7, 1888		Mayhew, E. W. A. Augustine, Freemantle, Western Australia
Dec. 1, 1887		‖McArthur, John, F.R.S.E., 196, Trinity-road, Wandsworth Common, S.W.
Feb. 2, 1888		McBretney, Edmund G., Pontefract-road, Castleford, York
Feb. 21, 1889		McCalman, George, India-street West, Glasgow
Feb. 6, 1890		McConnell, Arthur H., 35, Bernard-street, Russell-square, W.C.
Feb. 4, 1875		McCowan, William, F.I.C., The Brewery, Reading
Nov. 20, 1890		McCubbin, William A., Mill Bank House, West Derby, Liverpool
Dec. 17, 1857		McDougall, Alexr., 61, Liverpool-road, Birkdale, Southport
Dec. 17, 1874		McDougall, John, Clifton House, Greenwich-park, S.E.
June 15, 1893		McElroy, K. P., 1412, 16th-street, Washington, D C., U.S.A.
Feb. 18, 1892		McFall, J. E. Whitley, Bankfield-road, West Derby, Liverpool
Mar. 3, 1887	Trans.	McGowan, George, Ph.D., Harris Institute, Preston
May 4, 1893		McGregory, Joseph Frank, Prof., Hamilton, New York, U.S.A.
June 15, 1893		McKerrow, Charles Alexander, 41, Eccles Old-road, Pendleton, near Manchester
May 5, 1892		McKerrow, William James, D.Sc., 10, Glennoke-terrace, Hyde Vale, Greenwich, S.E.
Nov. 20, 1890		McKillop, John, Pulobo, Brani Smelting Works, Singapore
Feb. 6, 1868	Trans.	McLeod, Herbert, F.R.S., Indian Civil Engineering College, Cooper's Hill, Staines
Feb. 17, 1881		McMillan, Walter George, Metallurgical Laboratory, Mason College, Birmingham

Date of Election.		
April 4, 1889	Trans.	‖McMurtry, George Cannon, Wallaroo Smelting Works, Wallaroo, S. Australia
Feb. 18, 1882		McRoberts, George, Todhill, Newton Mears, Renfrewshire, N.B.
Feb. 18, 1892		Meacham, Chas. Stephen, Pettridge, Maidstone
Feb. 16, 1871	Trans.	‖Meldola, Raphael, F.R.S., 6, Brunswick-square, W.C.
Feb. 15, 1894		Melland, Godfrey, B.Sec., Victoria Park, Manchester
May 20, 1875		Melmore, Pattinson B., Chemical Laboratory, Maryport
Nov. 19, 1885		Menzies, Thomas J., M.A., B.Sc., Rector, Stranraer Academy, Stranraer, Wigtown
Dec. 18, 1884		Mercer, Francis M., 89, Bishopsgate-street-within, E.C.
Dec. 5, 1889		Mercer, Thomas, Great Hey, Edenfield, near Bury, Lancashire, and ring Bank Brewery, Edenfield, near Bury
May 7, 1891		Merrils, Frederick Johnson, 371, Glossop-road, Sheffield
April 20, 1876	Trans.	‖Messel, Rudolph, Ph.D., Silvertown, Essex
June 21, 1888		‖Miers, Henry A., M.A., F.G.S., Suffield-chambers, 79, Davies-street, Berkeley-square
Dec. 18, 1843		‖Millar, James, care of Andrew M. McCrindell, 76, Buccleuch-street, Glasgow
Feb. 18, 1892		Millar, James Hill, Mason College, Birmingham
Feb. 19, 1891		Millard, Edgar J., 33, Lothair-road South, Finsbury Park, N.
Feb. 19, 1880	Trans.	‖Miller, A. K., Ph.D., 111, Plymouth Grove, Manchester
Feb. 21, 1889		Miller, Harry East, Ph.D., 1264, Fourteenth-street, Oaklands California
April 4, 1889	Trans.	Miller, James Bruce, A.I.C., Rubislan, Den North, Aberdeen
Dec. 1, 1887	Trans.	Miller, John A., Niagara University, Buffalo, New York
May 7, 1885	Trans.	‖Miller, N. H. J., Ph.D., Harpenden, Hertfordshire
June 15, 1893	Proc.	Mills, Charles, 21, St. Mary Abbotts-terrace, W.
Dec. 18, 1862	Trans.	‖Mills, E. J., D.Sc., F.R.S., Young Professor of Technical Chemistry in the Glasgow and West of Scotland Technical College, 60, John-street, Glasgow
May 7, 1885		Milne, Alexander, M.A., M.B., Surgeon, Indian Medical Department, Bombay, and Byculla, Bombay
June 21, 1877		Milne, G. A., Chemical Laboratory, 18, John Brown-street, Bolton
May 5, 1892		Milnes, Ernest E., Ashfield, Bradford
Dec. 1, 1887		Mingaye, John C. H., Department of Mines, Assay Branch, Sydney
May 7, 1891	Proc.	Mitchell, Charles Ainsworth, B.A. Oxon., 33, Waldegrave-road, Upper Norwood, S.E.
June 18, 1891		Mitchell, Thomas, c/o E. Mitchell, Esq., Cressmount, Bridgend, Perth, N.B.
Feb. 16, 1893		Mole, H. Bloome, Hill Side, Shepton Mallet
Feb. 15, 1872	Trans.	‖Mond, Ludwig, F.R.S., 20, Avenue-road, St. John's-wood, N.W.
Feb. 18, 1892		Mond, Robert Ludwig, M.A., F.R.S.E., The Poplars, 20, Avenue-road, Regent's Park, N.W.

Date of Election.		
Dec. 18, 1879		||Mondy, Edmund F., Government Engineering College, Howrah, Calcutta, India
Mar. 3, 1887	Proc.	||Moody, G. Tattersall, D.Sc., Lorne House, North Dulwich, S.E.
May 5, 1892		||Moor, Cresacre George, B.A., 101, Leadenhall-street, E.C.
Dec. 15, 1892		Moorwood, Francis Colin, 260, Barnsley-road, Sheffield
Dec. 2, 1886		Moos, N. A. F., Poona, India
Feb. 19, 1891		Moore, Frederick Herbert, Strada degli Argentieri, 19, Messina, Sicily
Mar. 6, 1890		Moore, Ira, Ph.D., 70, Taylor-street, Tonge, Middleton, near Manchester
May 4, 1893		Monson, Henry John, 19, Norwood-street, Ashford, Kent
Feb. 18, 1864		Morfit, Campbell, Ph.D., 132, Alexandra-road, Abbey-road, N.W.
Feb. 21, 1889		Morgan, Arthur F., Chemical Laboratory, Central Chambers, Newport, Mon.
Jan. 7, 1888		||Morgan, John James, Riverdale, Abergavenny, Mon.
April 3, 1873		Morgan, William, Ph.D., The Technical Institute, Nelson-terrace, Swansea
Dec. 7, 1893		Morgan, J. R. Leydenbergh, Port Hall-street, Glasgow
June 17, 1880	Trans.	Moritz, Edward R., Ph.D., 72, Chancery-lane, W.C.
Dec. 18, 1879	Trans.	||Morley, H. Forster, M.A., 47, Broadhurst-gardens, South Hampstead, N.W.
May 5, 1892		Morris, Albert, 115, Hope-street, Dunkinfield
Feb. 19, 1880	Trans.	Morris, G. Harris, Ph.D., 72, Chancery-lane, W.C., and 13, Gwendwr-road, West Kensington, W.
Dec. 3, 1874		Morris, John Edward, Park Dale, Wolverhampton
Dec. 3, 1891		Morris, Joseph, Stamford-street, Mossley, near Manchester
Nov. 4, 1869		Morrison, John, Chemical Engineer, St. Peter's Chemical Manure Works, Newcastle-on-Tyne
May 7, 1891		Morrison, George R., Richmond House, Plaistow, Essex
June 20, 1889		Morrow, Henry W., M.S., Ph.D., 1210, Delaware-avenue, Wilmington, Delaware, U.S.A.
Dec. 15, 1851		Morson, Thomas, 124, Southampton-row, Russell-square, W.C., and 42, Gordon-square, W.C.
Feb. 16, 1872		Morton, Edward Handfield, Campayne Mansions, Campayne-gardens, South Hampstead
Dec. 7, 1893		Morton, Frederick, 101, Quarmby-road, Huddersfield
Feb. 7, 1884		Morton, Percy, Christ College, Brecon, South Wales
April 17, 1890	Trans.	Mosenthal, Henry de, 220, Winchester House, Old Broad-street, E.C.
Jan. 19, 1871		||Moss, John, 30, Tressillian-road, St. John's, S.E.
Jan. 19, 1871		Moss, Richard J., F.I.C., St. Aubyn, Ballybrack, Co. Dublin
Dec. 2, 1880		||Mott, H. A., Ph.D., 61, Broadway, Room 56, New York
April 15, 1886		Moul, Frank, Aldersgate Chemical Works, Southall

Date of Election.		
June 21, 1888		Mousley, Frank, c/o Mrs. Mousley, 2, Featherston-road, King's Heath, Birmingham
June 18, 1891		Mousley, H. J. Marston, Kingsbury, 19, Larches-street, Camphill, Birmingham
Feb. 16, 1884		‖Moyle, R. E., B.A., Heightley, Chudleigh, Devon
June 19, 1884	Trans.	Mueller, Baron Ferdinand Von, K.C.M.G., M. and Ph.D., F.R.S., Melbourne, care of Dulau and Co., 37, Soho-square
Jan. 17, 1889		Muir, James, The Yorkshire College, Leeds
Feb. 16, 1871	Trans.	Muir, M. M. Pattison, M.A., Fellow and Prælector in Chemistry, Gonville and Caius College, Cambridge
Mar. 30, 1870		‖Muirhead, Alexander, D.Sc., The Lodge, Shortlands, Kent
April 17, 1890		Müller, George, Prof., Ph.B., c/o Puge Sound Reduction Co., Everett, Washington, U.S.A.
Feb. 3, 1859	Trans.	‖Müller, Hugo, Ph.D., F.R.S., 110, Bunhill-row, E.C.; and 13 Park-square East, Regent's-park, N.W.
May 4, 1893		Munby, Alan E., Pension Internationale, Aulage, Heidelberg
Mar. 15, 1888		Munroe, Charles E., Prof. Columbia University, Washington, D.C., U.S.A.
Dec. 7, 1871		‖Munro, Donald, M.D., C.M., D.P.H., Medico-Legal Department, University of Glasgow
Feb. 17, 1876	Trans.	Munro, J. M. H., D.Sc., College of Agriculture, Downton, Salisbury
May 4, 1893		Murray, J. Alan, Aberystwyth, 20, Queen's-road, and University College of Wales, Aberystwyth
Feb. 15, 1894		Murray, John Moore, Esq., Highfield, Holmes Chapel, Cheshire
Jan. 21, 1869		‖Muspratt, E. K., Seaforth-hall, near Liverpool
Dec. 3, 1873		‖Muspratt, Sidney Knowles, 51, Croxteth-road, Liverpool
Dec. 4, 1890	Trans.	Murray, Thomas Smith, D.Sc., Chemical Department, Marischall College, Aberdeen
Nov. 3, 1870	Trans.	Muter, John, M.A., Ph.D., F.R.S.E., F.I.C., Laboratory, 325, Kennington-road, London, S.E., and Winchester-house, Kennington-road, S.E.
Dec. 4, 1890		Myers, Harry C., Ph.D., Stanford University, Palo-Alto, California, U.S.A.
Feb. 18, 1892		Myers, William Shields, B.Sc., 98, Easton-avenue, New Brunswick, U.S.A.
Mar. 6, 1890		Myles, John, M.A., B.Sc., Principal, Reinet College, Cape Colony
Feb. 3, 1887		Nagel, David Henry, M.A., Trinity College, Oxford
Mar. 5, 1874		‖Napier, Arthur S., care of Herren Mayer & Müller, 51, Markgrafen-strasse, Berlin, W., Germany
June 21, 1877		Napier, James, 89, London-road, Ipswich

Date of Election.		
June 15, 1893		Napier, John Watson, Clippens Oil Company, Loamhead, N.B.
Dec. 5, 1878		Napper, Edward W., The Hollies, Vicarage-lane, Bowdon
Feb. 7, 1878		Nason, Henry B., Ph.D., M.D., LL.D., Prof. of Chemistry, Rensselaer Polytechnic, Troy, State of New York
Dec. 3, 1891		Naylor, William, 16, Walton's-parade, Preston
April 4, 1878		Naylor, W. A. H., 38, Southwark-street, S.E.
Dec. 3, 1891		Neilson, Thomas, care of the Oregon Iron and Steel Company, Oswego, Oregon, U.S.A.
April 4, 1889		Nesbitt, William Beattie, B.A., M.D., 270, College-street, Toronto, Ontario, Canada
Dec. 5, 1889		Nettleton, J. A., 2, Barrows-terrace, The Mount, Belfast
April 4, 1878	Trans.	||Nevile, R. H. C., Crown Lea, Malvern
June 1, 1871	Trans.	Nevill, Edmund Neville, Government Laboratory, Durban, Natal
April 17, 1890	Trans.	Neville, Francis Henry, Sidney College, Cambridge
June 16, 1892		Newall, John Fenton, 8, Market-place, Manchester
June 4, 1885		||Newbolt, Francis George, Oakley-lodge, Weybridge
April 19, 1860	Trans.	||Newlands, John A. R., Laboratory, 27, Mincing-lane, E.C.
Feb. 18, 1864		Newlands, B. E. R., 11, Dunsmure-road, Stamford-hill, N.
Dec. 3, 1891		||Newlands, William, P. R., 1, Mildenhall-road, Lower Clapton, N.E.
Feb. 6, 1890		Newman, William Samuel, The Leez, Madras, India
April 4, 1889		Newsholme, G. T. Wilkinson, 74, Market-place, Sheffield
Dec. 18, 1879		||Newton, Howard, Singapore, Straits Settlements
Mar. 4, 1886		Newton, Walter, Park-green, Macclesfield
Mar. 1, 1883		Newton, William, Ph.D., F.I.C., 39, Mincing-lane, London, E.C.
Dec. 15, 1892		Nickolls, J. Bate, The Laboratory, Guernsey
Feb. 16, 1870	Trans.	||Nicholson, Edward, Brigade Surgeon, 41, Sandy-road, Seaforth, Liverpool
June 4, 1885		Nicholson, T. Goddard, St. Thomas' Hospital, S.E.
Dec. 5, 1889		Nickels, Wallace Christopher, 14, Yew-grove, Cricklewood, N.W.
Feb. 1, 1883	Trans.	Nicol, W. W. J., Mason College, Birmingham
May 6, 1869		Noble, Captain Sir A., Engineer, Elswick Ordnance Works, Newcastle
Dec. 5, 1889		Norman, John T., 78, Chelverton-road, Putney, S.W.
April 4, 1861		Norrington, Frederick, 3, Downfield-road, Clifton, Bristol
June 16, 1892		Norris, Charles James, Greville House, Great Malvern
April 17, 1879		North, W., M.D., Nedderdale, Chapter-road, Willesden Green, N.W.
May 5, 1892		Northing, John, 96, Tritonville-road, Sandymount, Dublin
Dec. 18, 1854		Norton, Fletcher, Claremont, Huyton, Liverpool
April 4, 1878		||Norton, Prof. T. H., Ph.D., University of Cincinnati, Ohio, U.S.A.
June 18, 1891		Notter, J. Lane, M.A., M.D., West Cliff, Woolstone, Southampton

Date of Election.		
May 4, 1893		Oates, William Henry, Broomhall Park, Sheffield
Mar. 4, 1886		Obach, Eugene, Ph.D., F.I.C., 2, Victoria-road, Old Charlton, Kent
May 15, 1890		Oddy, Robert Walter, Waterhouse, Toad-lane, Rochdale
Jan. 19, 1873		Odling, Walter, 132, High-street, and at Messrs. Bass & Co., Burton-on-Trent
Jan. 17, 1848	Trans.	Odling, William, M.B., F.R.S., 15, Norham Gardens, Oxford
May 4, 1871		Ogston, G. H., Analytical Laboratory, 39, Lime-street, E.C.
Dec. 2, 1875		Oman, J. Campbell, Prof., Government College, Lahore, Punjab, India
June 20, 1889		O'Mahony, D. J., Queen's College, Cork
Dec. 4, 1890		Ormandy, Wm. Reginald, c/o W. Ormandy, 17A, King-street, Wigan
Nov. 4, 1869		Orme, Temple A., University College, W.C.
May 16, 1872		‖Ormerod, Joseph Arderne, M.B., M.R.C.P., 25, Upper Wimpole-street, W.
Dec. 1, 1887		‖Ormiston, Archibald R., Heathland, Uddingston; and 203, St. Vincent-street, Glasgow
June 15, 1893		Orr, Alexander, 109, Pitt-street, Sydney, Australia
Feb. 21, 1884	Proc.	Orsman, W. J., jun., The Roburite Explosives Co., Gathurst, near Wigan
Mar. 17, 1881	Trans.	O'Shea, L. Trant, Firth College, Sheffield
Dec. 1, 1887		Ostersetzer, Julius, Messrs. W. and H. M. Goulding, Manure Manufacturers, Dublin
April 20, 1876	Trans.	†O'Sullivan, C., F.R.S., 140, High-street, Burton-on-Trent
Mar. 1, 1883		O'Sullivan, James, 26, Ashby-road, Burton-on Trent
Mar. 17, 1887		O'Sullivan, Patrick T., South Charitable Infirmary and County Hospital, Cork.
May 7, 1891		Ough, Lewis, 6, Upper King-street, Leicester
Feb. 16, 1888		Overbeck, Otto G. S. L., 10, Town Hall-street, Grimsby
June 16, 1887		Overend, Fred. Lawrence, B.A. (Oxon), Blair Lodge School, Polmont Station, N.B.
Feb. 16, 1893		Owen, Robert Henry, Plas-y-coed, Troedyrhiw, near Merthyr-Tydvil
Feb. 19, 1891		Oxford, Arnold Whitaker, Rev. M. A., 8, Henrietta-street, Cavendish-square, W.
Dec. 15, 1851		Oxland, Robert, Dr., 32, Portland-square, near Plymouth
Dec. 21, 1871	Trans.	‖Page, Frederick James Montague, B.Sc., 54, Sutherland-street, Pimlico, S.W.
Jan. 17, 1884		‖Pallister, J. W., B.Sc., 22, Grimthorpe-terrace, Headingley, Leeds

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† Longstaff Medallist, 1884.

Date of Election.		
May 4, 1882		Palmer, Alfred Neobard, 19, King-street, Wrexham, North Wales
Nov. 19, 1868	Trans.	||Palmer, Dr. W. J., 32, Bassett-road, W.
April 19, 1888		Palmer, Henry John, Penleigh House, Cotham Grove, Bristol
April 17, 1879		Palmer, Walter, Westfield, Reading
Jan. 19, 1882		Parker, Joseph R., Fairbrace Villa, Sussex-avenue, Ashford, Kent
Dec. 7, 1882		||Parker, R. H., 35, Clifton-road, Maida-vale, W.
Jan. 17, 1889		Parker, Robert Hodgson, c/o Mr. Parker, senr., Buckingham-villa, Keynsham, Bristol
Nov. 20, 1890		Parkes, Thomas, 30, Hopwood-street, Barnsley
Nov. 2, 1865	Trans.	||Parkinson, James, F.G.S., Queen's-chambers, Pirie-street, Adelaide, South Australia
May 4, 1893		Parrish, S., 15, Fenton-street, Woodhouse lane, Leeds
Feb. 18, 1892		Parry, Ernest John, B.Sc., 134, Upper Thames-street, E.C.
Feb. 17, 1876	Trans.	Parry, John, Ebbw Vale Works, Monmouthshire
May 17, 1888		Parsons, William, Dispensary, St. Bartholomew's Hospital, E.C.
April 21, 1870		Patchett, Isaac, F.I.C., 1, Leopold-square, Leeds
Feb. 15, 1882		Paterson, David, Lea Bank, Roslin, N.B.
June 21, 1888		Paterson, James Rymer, B.Sc., 10, Millerfield-place, Edinburgh
Mar. 5, 1885	Trans.	Patterson, George, The Mambré Saccharine Co., Hammersmith, S.W.
Mar. 17, 1870	Trans.	Patterson, T. L., care of Messrs. John Walker and Co., Greenock
Dec. 3, 1863	Trans.	Pattinson, John, 75, The Side, Newcastle-upon-Tyne
Mar. 5, 1868	Trans.	||Paul, Dr. B. H., Analytical Laboratory, 1, Victoria-street, Westminster, S.W.
Dec. 3, 1885	Trans.	Paul, Lewis Gordon, Ph.D., Messrs. Read, Holliday and Sons, Huddersfield
Dec. 7, 1893		Payne, George, F.M.D., Atlanta, Georgia, U.S.A.
Jan. 17, 1889		Peace, Frank Kenworthy, c/o George Peace, Monton Grange, Eccles, near Manchester
Feb. 15, 1894		Pearson, William Henry, 5, Bryn-villas, Blaina, Mon.
Jan. 16, 1874	Trans.	Pearce, William, jun., Chemical Works, Bow Common, E.
Feb. 15, 1894		Peden, John, jun., Chemical Laboratory, 11, Duff-street, Greenock
Feb. 4, 1870	Trans.	||Pedler, Alexander, Prof., Presidency College, Calcutta
May 20, 1886	Proc.	Pendlebury, William Henry, M.A., 6, Gladstone-terrace, Dover
Mar. 7, 1870		Penney, M. D., 11, High-street, Hull
Dec. 16, 1886		Pentecost, Stephen James, Nottingham-road, New Basford, Nottingham
Jan. 17, 1889		Percival, John, M.A., Carperby, Bedale, Yorks
April 17, 1884	Proc.	Perkin, A. G., 8, Montpelier-terrace, Hyde Park, Leeds
June 18, 1891	Trans.	Perkin, Frederick M., Owens College, Manchester
Dec. 15, 1856	Trans.	†||Perkin, W. H., Ph.D., F.R.S., The Chestnuts, Sudbury, Harrow

† Longstaff Medalist, 1888.

Date of Election.		
April 17, 1884	Trans.	Perkin, W. H., jun., F.R.S., Fairview, Wilbraham-road, Fallowfield, Manchester
Feb. 6, 1890	Proc.	Perman, Edgar Philip, D.Sc., University College, Cardiff, and 1, Gordon-road, Neath, Cardiff
Dec. 6, 1888		Perry, George Edward, 6, Norwood-villas, Edgbaston, Birmingham
May 2, 1867		Peterson, F. W., 54, Talbot-road, Bayswater, W.
June 16, 1881		Philip, Arnold, 43, Onslow-road, Richmond
Feb. 1, 1877		Phillips, A. G., 18, Fopstone-road, Kensington, S.W.
June 20, 1889		Phillips, Benjamin, 16, Finsbury-circus, E.C., and Oriental Bank-buildings, Bombay, India
Feb. 16, 1882		Phillips, Henry Harcourt, 183, Moss-lane East, Manchester
Feb. 21, 1889		Phillips, Henry Joshua, Ebbw Vale Iron Works, Ebbw Vale, Mon.
Jun. 16, 1887		Phillips, J. Stanley H., 6, Albany, Piccadilly, W.
Jan. 16, 1862	Trans.	Phipson, T. L., Ph.D., Laboratory of Analytical Chemistry, Putney, S.W., and Holtham Villa, Putney, S.W.
Feb. 19, 1891		Pickering, M. Samuel, 40, Price-street, Burslem
Feb. 7, 1878	Trans.	||Pickering, Percival Spencer Umfreville, M.A., F.R.S., 48, Bryanston-square, W., and Harpenden, Herts
April 17, 1890	Proc.	||Picton, Harold, B.Sc., 80, Regents Park-road, N.W.
Dec. 5, 1889		Pike, Alfred Edridge, 28, Albemarle-street, Piccadilly, and 19, Gilmore-road, Lewisham, S.E.
Jan. 15, 1874	Trans.	||Pike, William Herbert, Ph.D., School of Practical Science, Toronto, Canada
Dec. 20, 1883		||Pilley, John J., Ph.D., Crescent Lodge, Camberwell Grove, S.E.
Dec. 5, 1889		Ping, William, 2, Sandbourne-road, Brockley, S.E.
Feb. 21, 1889		Pingstone, G. Arthur, Casino Ingles, Minas de Rio Tinto, Provincia de Huelva, Spain
Mar. 17, 1881		Pisani, O. V., Gibraltar-house, Rochmount-road, Upper Norwood
Feb. 16, 1882		Pitt, Theophilus, 16, Coleman-street, E.C.
Feb. 16, 1893		Platt, Charles, Ph.D., John Hopkins University, Baltimore, Md., U.S.A.
April 4, 1889		Platts, John Charles, 25, Harcourt road, Crookesmoor, Sheffield
Dec. 4, 1890		Platts, Thomas, St. Andrews, Chesterton-lane, Cambridge
Nov. 15, 1860		||Player, J. H., 16, Prince Arthur-road, Hampstead, N.W.
Feb. 23, 1841	Trans.	||*Playfair, Right Hon. Lord, K.C.B., F.R.S., 68, Onslow-gardens, South Kensington
Dec. 2, 1880	Trans.	Plimpton, R. T., Ph.D., 23, Lansdowne-road, Clapham-road, S.W.
April 1, 1858		Pochin, Henry Davis, c/o W. G. Gover, 3, Malvern-villas, Camden-road, Bath
June 7, 1888		Pollard, F. Ernest, Old Cross, Hertford
Feb. 15, 1894		Pollok, J. Holmes, 37, Athole-gardens, Glasgow
Dec. 4, 1890		Pond, James Alexander, Auckland, New Zealand

Date of Election.		
Dec. 4, 1848		Pontifex, Edmund A., M.I.C.E., 72, Cornwall Gardens, S.W.
Mar. 6, 1862		Pooley, Thomas A., B.Sc., F.I.C., 121, The Grove, Denmark Hill, S.E.
Feb. 19, 1891		Pope, Wm. Jackson, Central Institution, Exhibition-road, S.W., and 16, Barclay-road, Walham Green, S.W.
Feb. 16, 1882		Porter, Herbert, 22, Waldegrave-road, Norwood, S.E.
Dec. 18, 1884		Porter, T. Cunningham, Rev., Eton College, Windsor
Dec. 6, 1883		Potter, Charles E., care of Messrs. Tate & Sons, Love-lane Sugar Refinery, Liverpool
Feb. 21, 1884		Power, Francis R., The Royal Mint, Melbourne
April 15, 1880		Preller, Charles S. Du Riche, M.A., Ph.D., A.M.I.C.E., F.G.S., c/o Messrs. Héritiers Schulthers, Bankers, Zurich, Switzerland
May 19, 1864		‖Prentice, Manning, Woodfield, Stowmarket
Mar. 2, 1876	Trans.	Prescott, Albert B., M.D., University, Ann Arbor, Michigan, U.S.A.
May 16, 1861		Prestwich, Joseph, F.R.S., Shoreham, Sevenoaks, Kent
Dec. 5, 1872	Trans.	Prevost, E. W., Ph.D., Elton, Newnham, Gloucester
May 4, 1882		‖Price, Arthur F., 524, Sacramento, San Francisco
Jan. 17, 1889		Priestley, Charles W., B.Sc., Vivian Institute, Torquay
Dec. 3, 1891		Priestley, Lawrence, Newark-on-Trent
Feb. 17, 1870		Pritchard, Prof. William, President Royal Veterinary College, N.W.; and 5, Regent's Park-road, Gloucester-gate, N.W.
June 15, 1871	Trans.	Procter, Henry R., F.I.C., The Yorkshire College, Leeds
April 4, 1889		Proctor, Charles, Upland House, 359, Upland-road, Dulwich, S.E.
Jan. 17, 1889		Provis, John, Emu Bay, Tasmania
June 15, 1882		‖Pullar, Rufus D., Ochil Perth
Nov. 15, 1888	Proc.	Pullinger, Frank, B.A., 27, Queen's-road, Oldham
Feb. 18, 1892	Trans.	Pullinger, William, 63, Holywell-street, Oxford
June 21, 1883		Purcell, M. F., 71, Harcourt-street, Dublin
June 3, 1875	Trans.	Purdie, Thomas, Ph.D., B.Sc., Assoc. R.S.M. University, St. Andrews, N.B.
Dec. 2, 1886		Pyke, L. S. M., St. Stephen's Club, Westminster, S.W.

Dec. 2, 1886		Quayle, Edwin, Belmont, 130, Flixton-road, Urmston, Manchester
Mar. 4, 1868		Quibell, Oliver, Magnus Lodge, Newark-on-Trent
Feb. 15, 1894		Quinn. J. Cardwell, 503, Romford-road, Forest Gate, E.
Dec. 5, 1889	Trans.	Quinoke, Frederick, Ph.D., 25, Alma-square, Abbey-road, N.W.

April 17, 1879		Rait, George Logan, 5, Fordwych-road, West Hampstead, N.W.
Dec. 15, 1892		Ramage, Hugh, Royal College of Science, Dublin
Nov. 15, 1888		Ramsay, A. Alexander, Anan Villa, Rose-road, Auckland

Date of Election.		
Mar. 20, 1873	Trans.	‖Ramsay, W., Ph.D., F.R.S., University College, W.C.
May 7, 1891		Randall, Percy Morrice, 3, Belsize Park Gardens, N.W.
April 18, 1843		Randall, William B., Glenhurst, Southampton
Dec. 3, 1885		Ranken, Charles, Stockton-road, Sunderland
May 16, 1889		Ransom, Francis, 12, Bancroft, Hitchin
April 21, 1887		Rawlins, Edward, 114, Burley-road, Leeds
June 17, 1880		Rawson, Christopher, 2, Melbourne-place, Bradford
Jan. 17, 1884	Trans.	‖Rawson, Sidney George, D.Sc., Westbourne, Westbourne-grove, West Kirby, Cheshire
June 17, 1886		Ray, William, Fir Bank, Hereford-square, Sale, near Manchester
April 4, 1889		Read, Arthur A., Ventnor House, Honiton, Devon
Nov. 20, 1890		Redding, Richard James, 17, Leghorn-road, Plumstead, S.E.
Jan. 15, 1874		‖Reddrop, Joseph, Laboratory, London and North West. Ry., Crewe
July 16, 1892		Redman, Henry Ramsden, 10, The Gardens, East Dulwich, S.E.
June 20, 1889		Redwood, Robert, 4, Bishopsgate-street-within, E.C.
Jan. 18, 1866		Redwood, Boverton, F.R.S.E., 4, Bishopsgate-street-within, E.C.
Mar. 17, 1887		Redwood, T. Horne, 2, Fisher-street, Red Lion-square, W.C.
Nov. 18, 1886	Trans.	Rée, Alfred, Ph.D., 1, Brighton-grove, Rusholme, Manchester
Dec. 7, 1893		Rees, George Percival, Ely House, Basford, Stoke-on-Trent
Nov. 16, 1882		Reed, Lester, F.I.C., Hyrst-hof, 8, South Park-hill-road, Croydon, S.E.
April 15, 1880		‖Regester, William, Lawn-lodge, Isleworth, Middlesex
Dec. 7, 1893		Reid, Thomas Anderson, Lostock, Gralan, Northwich
Dec. 15, 1881		Reid, Walter Francis, Fieldside, Addlestone, Surrey
June 17, 1886		Remington, J. Price, Prof., 1832, Pine-street, Philadelphia, Pa., U.S.A.
Feb. 6, 1879	Trans.	Rennie, Edward H., Ph.D., University of Adelaide, S. Australia
May 17, 1888		Reynolds, Colonel Henry Charles, Thorncliff, Sandown-road, Cheltenham
June 19, 1873	Trans.	Reynolds, James Emerson, Prof., F.R.S., Trinity College, Dublin,
Nov. 19, 1857		Reynolds, Richard, 13, Briggate, Leeds
June 18, 1891		Rhodes, Edward, Highfields, Frodsham, Cheshire
May 18, 1876		Richards, D. H., Bryntirion, Oswestry
April 4, 1889		Richards, Duncan T., 3, Madeira-terrace, Westoe-lane, South Shields
Jan. 17, 1889		‖Richards, Edgar, 1621 H. Street, Washington, D.C., U.S.A.
Jan. 1889		Richards, Percy A. E., A.I.C., 44, Sinclair-road, Kensington, W.
June 17, 1886		Richards, William, B.Sc., The Clock House, Tooting, S.W.
May 5, 1892		Richardson, Albert Ernest, Fairlight, Knight's-park, Kingston-on-Thames
June 18, 1885	Trans.	‖Richardson, Arthur, 22, Meridian-place, Clifton, Bristol
Feb. 16, 1888		‖Richardson, Clifford, Office of the Engineer Commissioner, Central Power Station, G.R.R., Washington, D.C., U.S.A.
Feb. 1, 1883		Richardson, F. W., 2, Farcliffe-place, Bradford

Date of Election.		
Mar. 6, 1873		Richardson, Henry, 127, Elizabeth-street, Cheetham, Manchester
Dec. 6, 1888		Richardson, Hubert N. B., The Hawthorns, Knighton Park-road, Leicester
April 19, 1866		Richardson, Joseph, jun., 40, Warwick-road, Chorlton-cum-Hardy, Manchester
Dec. 1, 1864		Richardson, J. G. F., Ph.D., Elmfield, Knighton, Leicester
May 5, 1892		Richardson, Reginald, E. S., Elmfield, Knighton, Leicester
Nov. 17, 1887		Richardson, W. H., Dudley
Mar. 3, 1887		Richmond, H. Droop, 50, Clanricarde-gardens, Notting-hill-gate, W.
Feb. 3, 1845		Rickard, W. T., 136, Maygrove-road, West Hampstead, N.W.
Dec. 7, 1882	Trans.	Rideal, Samuel, D.Sc., F.I.C., 28, Victoria-street, Westminster, S.W.
April 3, 1873		Rider, Alonzo John, 4, Haddington-road, Stoke, Devonport
Feb. 16, 1882	Trans.	Ridsdale, C. H., Hutton-grange. Guisbrough. Yorks
Dec. 6, 1888		Rigby, John S., 35, Bagot-street, Wavertree, Liverpool, and Ditton, Lancashire
Dec. 15, 1851	Trans.	Riley, Edward, 14A, Finsbury-square, E.C.
Dec. 4, 1873		Rimmington, F. M., Bradford
May 4, 1893		Rintoul, William, 43, King William-street, Greenwich, S.E.
June 15, 1893		Ritchie, George, 8, Buchanan-gardens, Mount Vernon, N.B.
Mar 3, 1864		Ritchie, William, jun., Kincaid-field House, Milton of Campsie, Glasgow
May 4, 1893		Robbins, James H., 4, Roderick-road, Haverstock Hill, N.W.
April 13, 1872		Robbins, John, 57, Warrington-crescent, Maida-vale, W.
June 20, 1889		Roberts, Emmanuel, M.D., Moratniva, Ceylon
June 21, 1883		Roberts, Frederick G. Adair, Warton-road, Stratford, E.
Jan. 20, 1876		Roberts, Martin Fenn, Postal Telegraph Factory, Mount Pleasant, Clerkenwell, E.C.
April 4, 1889		Roberts, R. Wightwick, c/o A. W. Rowe, Esq., Dashwood House, 9, New Broad-street, E.C.
Feb. 19, 1880		Roberts, W. Brittain, Wilderspool House, Warrington, Lancashire
Nov. 7, 1866	Trans.	Roberts-Austen, William Chandler, C.B., F.R.S., Royal Mint, E.
Feb. 15, 1894		Robertson, A. B., Dangayne, Bearsden, by Glasgow
Mar. 17, 1887		Robertson, George, Madeira-villa, Woodford Green, Essex
Dec. 4, 1890		Robertson, George Henry, 30, Hemstall-road, West Hampstead, N.W.
Feb. 21, 1889		Robins, Harry H., Messrs. Southwell and Co., Dockhead, S.E.
May 5, 1881		Robinson, G. Carr, Royal Institution, Hull
Nov. 16, 1882	Trans.	Robinson, Henry H., M.A., Imperial College, Hankow, China
May 3, 1866		Robinson, John, Cantley-mansions, Fairhazel gardens, Hampstead, N.W.
Dec. 15, 1892		Robson, James, Andersonian-buildings, 204, George-street, Glasgow

Date of Election.		
Dec. 15, 1892		‖Rodger, James Wyllie, 76, Anerley-park, S.E.
Dec. 20, 1883		Rogers, Arthur W., Todcaster Tower Brewery Co., Todcaster
Jan. 17, 1884		Rogers, Francis M., 21, Burma-road, Stoke Newington, N.
April 15, 1886		Roose, Robson, M.D., 45, Hill-street, Berkeley-square, W.
Dec. 17, 1855	Trans.	Roscoe, Sir H. E., M.P., LL.D., F.R.S., 10, Bramham-gardens, South Kensington, S.W.
Feb. 19, 1891		Rose, Tom Kirke, 9, Royal Mint, E.
Feb. 15, 1894		Ross, Arthur, 1, Glengall-road, Old Kent-road, S.E.
Feb. 17, 1870		Ross, Lewis Buttle, Driffield
Dec. 15, 1881		Ross, Rev. Henry, LL.D., Dallas House, Lancaster
June 18, 1891	Proc.	Rossiter, Edmund Charles, 145. Church-lane, Smethwick
Feb. 18, 1892		Rothewell, C. F. Seymour, 88, George-street, Moss Side, Manchester
Mar. 6, 1890		Rothwell, Robert R., 88, George-street, Moss Side, Manchester
Feb. 15, 1894		Rouillard, Richard A., 2, Springfield-road, Wimbledon, S.W.
Dec. 19, 1872	Trans.	Routledge, Robert, B.Sc., The North-Eastern Railway Laboratory, Greenfield, Gateshead-on-Tyne
Feb. 15, 1894		Rowntree, Walter Smithson, 4, Claremont-terrace, York
June 17, 1880		‖Roy, Tarapusauna, Medical College, Calcutta
Mar. 20, 1862		‖Royle, Thomas, Dalton House, Upton-lane, Forest Gate, E.
Feb. 15, 1872	Trans.	Ruffle, John, Gnoll Brook, Neath, South Wales
Jan. 17, 1889	Trans.	Ruhemann, Siegfried, Ph.D., M.A., Gonville and Caius College, Cambridge
Feb. 15, 1883		Rumble, Charles, 31, Oberstein-road, New Wandsworth
Feb. 6, 1890		‖Russell, Edward, 36, Lucerne-road, Highbury Park, N.
Mar. 3, 1851	Trans.	‖Russell, W. J., Ph.D., F.R.S., 34, Upper Hamilton-terrace, St. John's-wood, N.W.; and St. Bartholomew's Hospital, E.C.
Feb. 16, 1870		‖Rylands, Thomas Glazebrook, F.L.S., Highfields, Thelwall, near Warrington
June 7, 1888		Sach, Albert J., Technical School, Goulburn, New South Wales
Feb. 19, 1891		Sacré, Howard C., 5, Ecclesford-road, Manchester
June 18, 1868		Sadler, S. A., Dr., Cleveland Chemical Works, Middlesborough
May 4, 1882		Sadtler, Samuel P., Ph.D., 145, North 10th-street, and 1042, Drexel-buildings, Philadelphia, U.S.A.
Dec. 20, 1883	Trans.	‖Saint, W. Johnston, Kurpierston Strasse, 5, Bonn, Poppelsdorf, Germany
June 19, 1879	Trans.	‖Sakurai, J., Science College, Imperial University, Tokyo, Japan
Feb. 19, 1880		Salamon, Alfred Gordon, 27, Holland-park, W.
Feb. 19, 1880		Salet, George, 120 Boulevard St. Germain, Paris
May 4, 1876		‖Salomons, Sir David Lionel, Broomfield, Tunbridge Wells; and Berkeley Chambers, 13, Bruton-street, Hyde-park, W.
April 16 1863		‖Salt, Henry, M.D.C.M., F.R.G.S., Inglewood, Great Malvern
Feb. 17, 1859		‖Salter, Thomas W., Hamilton House, The Croft, Hastings, Sussex

Date of Election.		
June 25, 1871		‖Salter, Mortyn John, Northcote, Beaconsfield-road, New Southgate
June 21, 1883		Samuel, Albert Henry, Annesley, 167, Lodge-lane, Sefton Park, Liverpool
May 4, 1882		Samuel, W. Cobden, Wilton Lodge, 337, Norwood-road, West Norwood, S.E.
Mar. 3, 1870	Trans.	‖Sandberg, C. P., 19, George-street, Westminster
Feb. 18, 1892		Sandercock, Thos. J. Buckler, Sidcup College, Sidcup, Kent
Dec. 6, 1888		Sanderson, John, Middlesborough, Kentucky, U.S.A.
Nov. 16, 1882		Sanford, P. Gerald, Laboratory, 20, Cullum-street, London, E.C.
Dec. 4, 1890		Saniter, Ernest Henry, The Laboratory, Wigan Coal and Iron Co., Wigan
Dec. 3, 1891		Sanyal, Abhayacharan, M.A., Professor of Physical Science, Queen's College, Benares, N.W.P., India
Dec. 15, 1892		Sarbadhicary, Satya-prosad, 1, College-street, Calcutta
June 17, 1886		Saunders, Prof. William, Experimental Farm, Ottawa, Ontario, Canada
Feb. 2, 1888		Saunders, W. Sedgwick, M.D., L.R.C.Phys.Ed., M.R.C.S., F.S.A., Medical Officer of Health for City of London, 13, Queen-street, Cheapside, E.C.
Feb. 6, 1890		Sayers, William Charles, 38, High-street, Lewisham, S.E.
Dec. 3, 1885		Scammell, Luther R., 42-4, King William-street, Adelaide, South Australia
June 21, 1877		Scarf, Sydney Isaac, F.I.C., City of London School, Victoria Embankment, E.C.; and 75, Oxford-road, Islington, N.
Feb. 6, 1873		Schacht, George Frederick, Windsor-terrace, Clifton, Bristol
Dec. 7, 1893		Schidrowitz, Philip, 102, Oxford-gardens, Notting Hill
Dec. 6, 1888		‖Schieffelin, William Jay, 170, William-street, New York, City, U.S.A.
Dec. 2, 1886		Schleselman, James, Victoria-chambers, Dundee
Dec. 15, 1892		Schloesser, Augustus, 7, Victoria-crescent, Busby, near Glasgow
Feb. 18, 1892		‖Schofield, James Alexander, University of Sydney, New South Wales
Mar. 15, 1842	Trans.	Schunck, Edward, Ph.D., F.R.S., Oaklands, Kersall, Manchester
June 18, 1863		Scorgie, James, Poona Villa, King's Gate, Beechgrove-terrace, Aberdeen
Dec. 18, 1879		‖Scott, Alexander, M.A., D.Sc., Chemical Laboratory, University Cambridge
April 17, 1890		Scott, Ernest George, 67, Lord-street, Liverpool
Mar. 3, 1887		Scrutton, W., Robinson's Ferry, Calaveras County, California, U.S.A.
Mar. 1, 1883	Proc.	Scudder, Frank, 39, Elmfield-road, Balham, S.W.
May 7, 1891		Searl, Albert, Montrena, Victoria-road, Sidcup

Date of Election.		
Nov. 20, 1890		Seaton, Edward Cox, M.D., The Limes, 56, North Side, Clapham Common, S.W.
June 21, 1888		Seely, Herbert W., 11, Corn-market, Halifax
April 15, 1875		Sellon, Scudamore, The Hall, Sydenham, S.E.
Dec. 15, 1892		Sell, William James, 1, Benet-place, Cambridge
Feb. 16, 1882		Sells, V. Perronet, 1, Woodsley-terrace, Leeds
Mar. 4, 1875	Trans.	Senier, Alfred, Prof., M.D., Ph.D., Queen's College, Galway
June 21, 1887		Senier, Harold, The Wigwam, Thurlow Park-road, West Dulwich, London, S.E.
Mar. 6, 1890		Sergeant, Edward, L.R.C.P. (Lond.), M.R.C.S. (Eng.), County Offices, Preston, Lancashire
Feb. 1, 1883		Serre, Charles A., Mitre Chemical Works, Cordova-road, Grove-road, Mile End.
June 15, 1893		Sessions, Wilfred, B.Sc., Leighton Park School, Reading
Jan. 20, 1870	Trans.	Seward, Henry, c/o Messrs. J. B. Freeman, Sons, and Co., Wandle Colour Works, Wandsworth, S.W.
Feb. 19, 1874		||Sexton, A. Humboldt, F.I.C., F.R.S.E., Professor of Metallurgy, Metallurgical Department, Andersonian-buildings, 204, George-street, Glasgow
June 20, 1880		Shadwell, J. E. L., Meadowbanks, Melksham, Wilts
Feb. 20, 1873		Shapleigh, Waldron, Welsbach Incandescent Gas Light Co., Factory, Gloucester City, New Jersey, U.S.A.
Dec. 7, 1893		||Shapley, Frederick, c/o Whittier, Fuller, and Co., 21, Front-street, San Francisco, California
June 4, 1874		Sharman, William, 247, Mare-street, Hackney, N.E.
June 18, 1885		Sharp, James, The Towers, Low Moor, near Bradford
Feb. 2, 1888		Shaw, Frederic W., Laboratory, Heapy Bleach Works, near Chorley, Lancashire
Dec. 15, 1892		Shaw, G. Arthur, 45, St. Petersgate, Stockport
Feb. 21, 1883		Shaw, Hârry G., 628, Montgomery-street, Room 47, San Francisco, California, U.S.A.
Feb. 19, 1891		Shaw, Herbert D., Bond-street, Dewsbury
Feb. 6, 1890	Trans.	Shaw, Saville, Durham College of Science, Newcastle-upon-Tyne
June, 16, 1887		Sheard, John T., Avenue-place, Brimington, Stockport
April 4, 1889		Shegog, Thomas Alexander, 4, Omsbersley-road, West Park, Newport, Mon.
Feb. 17, 1876	Trans.	Shenstone, W. A., Clifton College, Bristol; and 12, Clifton Park-road, Clifton, Bristol
May 21, 1874		||Shepherd, H. H. B., Northcote, Mount Pleasant-lane, Upper Clapton, N.E.
Dec. 16, 1886		Sheshadri, P. Y., The Mission House, Bethel, near Jaulna, via Bombay, India
Dec. 15, 1892		Shepherd, Reginald des Forges, 6, Coltman-street, Hull
June 18, 1891	Trans.	||Shields, John, Ph.D., D.Sc., University College, W.C.

Date of Election.		
Dec. 16, 1886	Trans.	Shimidzu, T., 1/0 Chicago, 2111, North Jefferson-street, Pictoria, Ills., U.S.A.
April 19, 1883		Shopoff, Vulko Ivan, Philippopolis, South Bulgaria
Nov. 18, 1886		Shutt, Frank, M.A., Experimental Farm, Ottawa, Canada
April 17, 1890		Shuttlewood, W. Brewin, 8, Clifton-road, Crouch End, N.
May 16, 1889		Sibson, Alfred Edward, 2, St. John's villas, Palmerston road, Buckhurst Hill, Essex
Dec. 15, 1859		Sibson, Alfred, 23, St. Mary Axe, E.C.
April 17, 1890		Sibun, James, 2, Lax-terrace, Norton, Stockton-on-Tees
Nov. 29, 1874	Trans.	Siebold, Louis, Broomville-avenue, Sale, near Manchester
Dec. 2, 1886		Silvester, Harry, Malvern House, Handsworth, Birmingham
Dec. 3, 1885		Sim, James, 77, Dee-street, Aberdeen
April 4, 1889		Simmonds, Henry, Gas Works, Colne, Lancashire
April 21, 1887		‖Simmons, L. Owen, Wolvesey, Winchester
1857		Simpson, Maxwell, M.D., F.R.S., 9, Barton-street, West Kensington
May 29, 1886	Trans.	‖Simpson, William Selby, 95, Darenth-road, Stamford Hill, N.
Dec. 7, 1893		Sims, W. Edgar, Stafford House, Longsight, Manchester
May 16, 1889		Singer, Ignatius, The Poplars, Capel-street, Calverley, Yorks.
April 15, 1880		Skelton, J. R., The Homestead, Thorpe Village, Norwich
Feb. 2, 1888	Trans.	Skinner, Sidney, M.A., The Cavendish Laboratory, Cambridge
Feb. 18, 1892		Skurray, Thomas, United Breweries, Abingdon, Berkshire
April 17, 1879		Slater, Charles, 16, Northwick-terrace St. John's Wood, N.W.
April 15, 1880	Trans	‖Slater, Harold H., Laboratory and Cement Testing Office, Grays, Essex
Dec. 5, 1878		Slatter, George W., A.R.C.S., F.I.C., Saltaire, Yorkshire
April 4, 1889		Slater, John W., 36, Wray-crescent, Tollington Park, N.
Feb. 5, 1863	Trans.	Smee, A. Hutchinson, The Grange, Hackledge, Carshalton, Surrey
Dec. 16, 1875		‖Smetham, Alfred, Analytical Laboratory, Cereal Chambers, 18, Brunswick-street, Liverpool
Dec. 5, 1872		Smith, A. Percy, 13, Gordon-street, Gordon-square, W.C.
June 21, 1883	Trans.	Smith, Adolphe, 19, Barclay-road, Walham Green
April 17, 1890		‖Smith, Alexander, Ph.D., B.Sc., Wabash College, Crawfordsville, Indiana, U.S.A.
Feb. 16, 1888		Smith, Angus, 10, Ardgordan street, W., Greenock, N.B.
Dec. 15, 1881	Trans.	Smith, Bernard E., Alkali Acts Department, Local Government Board, Whitehall, S.W.; and 73, Westmorland-road, Newcastle-on-Tyne
Feb. 15, 1894		Smith, Charles Henry, The Bungalow, Nassau, Bahamas, W.I.
Feb. 21, 1884		‖Smith, Edgar Francis, 35, Ampthill-square, Hampstead road, N.W.
Mar. 20, 1878		Smith, Edgar F., Prof., University of Penna., Philadelphia, Pa.
Dec. 9, 1869		Smith, Edward, Heathfield House, Chudleigh, Devon

Date of Election.		
June 16, 1892		Smith, Ernest Heber, 17, Carlisle road, Cambridge
Nov. 20, 1892		‖Smith, Fred., P.O. Box 1324, Johannesburg
April 2, 1874		Smith, George, Nobel's Explosives Co., Polmont Station, Scotland
Dec. 20, 1883		Smith, George, 141, Lothair-road, North Finsbury Park, N.
Feb. 18, 1892		‖Smith, George P. Darnell, 60, St. Michael's Hill, Bristol
Feb. 6, 1890		Smith, Harry Wood, B.Sc., Messrs. May and Baker, Garden Wharf, Church-road, Battersea
May 16, 1892		Smith, H. R., 1, Aubert-park, Highbury, N.
May 5, 1892		Smith, John Meadows, Laboratory, 66, College-street, Chelsea, S.W.
Dec. 18, 1879		Smith, John William, Mass. Institute of Technology, Royston-street, Boston, Massachusetts
Feb. 6, 1873	Trans.	Smith, Miles H., 3, Great Tichfield-street, Oxford-street, W.
Feb. 19, 1891		Smith, R. Greig, Durham College of Science, Newcastle-on-Tyne
Feb. 16, 1888		Smith, Sam, Ebor, Mount Pleasant-road, Exeter
Nov. 18, 1886		Smith, Sidney, 35, Ampthill-square, Hampstead-road, N.W.
April 7, 1856		Smith, Thomas J., F.G.S., Wilton-terrace, Hornsea, East Yorkshire
Feb. 3, 1876		Smith, W. A., M.A., M.B. Oxon, M.R.C.S. Eng., Newport, Essex
Dec. 20, 1866	Trans.	Smith, Watson, University College, Gower-street, W.C.
Dec. 20, 1883	Trans.	Smithells, Arthur, Professor, The Yorkshire College, Leeds
Dec. 18, 1873		‖Smyth, John, M.A., Milltown, Banbridge, Ireland
Mar. 3, 1887	Trans.	‖Snape, Henry Lloyd, Prof., Chemical Laboratories, University College of Wales, Aberystwith
May 16, 1872	Trans.	Snelus, George J., F.R.S., 2, Victoria-mansions, Victoria-street, Westminster, and 42, Lowther street, Whitehaven
Dec. 18, 1879		Snodgrass, James, 2, Keir-terrace, Maxwell-road, Pollokshields, Glasgow
Feb. 3 1887		Sohn, Charles, 25, Beverley-road, Anerley
June, 18, 1891		Solomon, Frank Oakley, 68, Fern-avenue, Newcastle on-Tyne
Dec. 17, 1874		Sonstadt, Edward, Church Field, Cheshunt, Herts
Dec. 18, 1884	Trans.	Sorabji Bomanji, Khan Bahadur, Ph.D., C.E. (Bombay) Assoc., M.I.C.E. (Lond.), 8, Sleater-road, Bombay
June 15, 1893		Sorrell, Henry Thomas, Holly Lodge, Millbrook-road, Southampton
May 6, 1875		Southall, Alfred, Garrick House, Richmond Hill, Edgbaston
June 21, 1883		Soward, Alfred W., 144, Friern-road, Dulwich, London, S.E.
Dec. 15, 1892		Spackman, Charles, 12, Beacon-road, Loughborough
Feb. 21, 1889		Speakman, James, Penhold, Post Office, Calgary, Alberta, Canada
Jan. 18, 1866		Speir, James, 110, Fenchurch-street, E.C.
Feb. 1, 1883		‖Spencer, Ernest Samuel, Elmstead, Merton-park, Surrey
April 4, 1878		Spencer, James, B.Sc., 38, Ash-grove, Bradford
Mar. 4, 1886		Spencer, Richard, Woodside, Crosland Park, Barrow-in-Furness
Feb. 6, 1879		‖Spencer, Samuel, Wetherby The Avenue, Lower Norwood

Date of Election.		
June 16, 1887		Spencer, W. Shelley, 165, Bridge-street, Farnworth, near Bolton, Lancashire
Feb. 3, 1859	Trans.	‖Spiller, John. 2, St. Mary's-road, Canonbury, N.
Jan. 15, 1863		‖Spiller, William, Atlas Dye Works, Hackney-wick, E.
June 18, 1885		Spilsbury, James, 4, Lynton-road, Crouch End, London, N.
June 4, 1885		‖Spottiswoode, W. Hugh, Balliol College, Oxford; and 41, Grosvenor-place, S.W.
Feb. 18, 1892		Spray, Henry John, c/o Messrs. Hopkins and Williams, Bridgefields, Wandsworth, S.W.
Dec. 1, 1864	Trans.	Sprengel, Hermann, Ph.D., F.R.S., Royal Prussian Professor (Titular), Savile Club, 107, Piccadilly, W.
May 4, 1882		‖Squire, P. Wyatt, 413, Oxford-street, W.
Feb. 4, 1858	Trans.	Squire, W. Stevens, Ph.D., Clarendon House, St. John's Wood park, N.W.
Feb. 18, 1892		Squires, Alfred James, 32, Derby-road, Farnworth, Widnes, Lanc.
May 5, 1892		Stables, William Herbert, Rev. B.A., The Green, Runcorn, Cheshire
June 21, 1877		Stacey, Henry George, 300, High Holborn, W.C.
Dec. 18, 1879	Trans.	Stallard, George, M.A., Horton Crescent, Rugby
April 21, 1859	Trans.	‖Stanford, Edward Charles, Glenwood, Dalmuir, Dumbartonshire
Mar. 17, 1887		Stanger, W. Harry, Chemical Laboratory, Broadway, Westminster
April 15, 1880		Stanley, John William, The Laboratory, Tondu, near Bridgend, Glamorgan
Feb. 3, 1887		‖Stansell, Lionell W., Bydews, Holland-road, Maidstone, Kent
Dec. 3, 1885		Staples, Henry J., Spondon, Derby
Dec. 15, 1870		Starey Arthur J., 18, Ashley-road, Hornsey-rise, N.
Dec. 15, 1870	Trans.	‖Stark, J. Fleming, Bromborough Pool, near Birkenhead
Mar. 16, 1876		Starling, J. H., Crossness, Belvidere, Kent
Feb. 17, 1881		Stavert, Rev. W. J., M.A., Burnsall Rectory, Skipton-in-Craven, Yorkshire
Nov. 16, 1882	Trans.	Stead, J. E., Redcar, Middlesborough
May 4, 1882		Stebbins, James H., jun., Ph.D., 114, Pearl-street, New York
June 16, 1887	Proc.	Steedman, Charles Ernest, Abberton House, Strand, Williamstown, Melbourne
May 7, 1885		Steel, Robert Elliot, Technical Schools, Plymouth
Dec. 5, 1889		Steel, Sydney, 26, Somerset-street, Portman-square, W.
Dec. 4, 1890		Steel, Thomas, c/o Colonial Sugar Refining Co., Sydney, N.S.W.
Dec. 18, 1884		Steele, Robert R., 8, Adelaide-square, Bedford
Jan. 17, 1884		Stenhouse, Thomas, 8, West-street, Rochdale
May 5, 1892	Proc.	Stenhouse, James, Gas Works, New-street, Edinburgh
Dec. 6, 1883		Stephens, C. W., 116, Wednesbury-road, Walsall
April 15, 1880		‖Stephens, Henry Charles, M.R. Inst., Avenue House, Finchley
Dec. 3, 1885		Stephenson, Stephen, 98, Kensington, Liverpool

Date of Election.		
Dec. 3, 1891		Stephenson, Thomas, Bellasis-road, Byculla, Bombay
Dec. 6, 1888		Stern, Arthur Landauer, 170, Ashby-road, Burton-on-Trent
Dec. 15, 1881		Steuart, Daniel Rankin, Broxburn, Linlithgowshire
Feb. 18, 1864		Stevenson, Thomas, M.D., Sandhurst Lodge, 45, Gresham-road, Brixton, S.W.
Feb. 6, 1879		Stevenson, William, 95A, Southwark-street, S.E.
June 20, 1872		‖Stewart, Walter, 1, Murrayfield Gardens, Edinburgh
Feb. 21, 1889		Stillman, Thomas B., Steven's Institute of Technology, Hoboken, N.J., U.S.A.
Dec. 15, 1881		Stitt, Charles Alfred, Horneleu Cheney Gardens, Edinburgh
June 21, 1866		Stock, W. F. K., 5, Dixon-terrace, Darlington
Feb. 19, 1891		Stockdale, R., the Grammar School, Leeds
June 18, 1874		‖Stocks, Frederic, Snead's Green House, Droitwich, Worcestershire
Nov. 17, 1887		Stocks, Herbert B., 54, Ferndale-road, Southdown-road, Liverpool
Mar. 5, 1885		Stocks, Joseph M., Ramsbottom Paper Mill Co., Ramsbottom, Lancashire
Dec. 3, 1885		Stoker, Henry, 5, Argyll Mount, Mansfield, Notts
April 17, 1879	Trans.	‖Stokes, A. W., Vestry Hall, Paddington
Dec. 18, 1873		‖Stone, Edward Daniel, Laboratory, 19, Lever-street, Piccadilly, Manchester
April 17, 1890		Stone, Frederick Richard M., 58, Upper Parliament-street, Liverpool
Dec. 2, 1875		‖Stone, J. Harris, M.A., F.L.S., Barrister-at-Law, 3, Dr. Johnson's-buildings, Temple, E.C.
April 17, 1879		‖Stone, William, M.A. Cantab, F.L.S., Oxford and Cambridge, Garrick, and Union Clubs, and D. 6, The Albany, Piccadilly
May 7, 1891		‖Storey, James Ashburner, B.Sc., Warakamure, Matale, Ceylon
June 19, 1884		Stormouth, Thomas, Athol House, Clarence-road, St. Thomas, Exeter
Feb. 3, 1887		‖Strangman, J. Pim, Sarno, Province of Salerno, Italy
May 7, 1885	Trans.	‖Stuart, Charles M., M.A., St. Dunstan's College, Catford, S.E.
June 19, 1884		St. Stephen, Raynor, Tregenna House, 25, Fordwych-road, Brondesbury
Dec. 7, 1893		Styles, R. Curling, Knockhall, Greenhithe, Kent
Dec. 4, 1890	Trans.	‖Sudborough, J. Joseph, B.Sc., Heidelberg Chemische Laboratorium der Universitats
Dec. 5, 1878	Trans.	‖Suguira, Shigetake, care of Tokio Chemical Society, No. 7, Nishikouyacho, Tokio, Japan
Feb. 16, 1888		Sumner, Robert Mason, c/o Messrs. Parke, Davis and Co., Detroit, Michigan, U.S.A.
April 21, 1887		Sutcliffe, Samuel, Mostyn, N. Wales
Feb. 3, 1887		‖Sutherland, D.A., F.I.C., 2, Victoria Mansions, Westminster, S.W.

Date of Election.		
Feb. 21, 1884		Sutton, C. W., 19, Henley-road, Ipswich
April 19, 1860		Sutton, F., Laboratory, Bank Plain, Norwich
Mar. 4, 1886		‖Sutton, F. Napier, 6, Grosvenor-gardens, Willesden Green
June 3, 1875		Swan, Joseph William, M.A., Lauriston, Bromley, Kent
June 20, 1889		Swan, Robert, M. W., 15, Walmer-crescent, Glasgow
Dec. 5, 1889		Sworn, Sidney Augustus, The New Municipal Technical Scho Gravesend
Feb. 18, 1892		Sykes, James, 76, Lockwood-road, Huddersfield
Feb. 19, 1891		Sykes, M. Carrington, L.P.H. Lond., L.R.C.P. Lond., M.R.C.S. Eng., L.S.A. Lond., Sykeshurst, Barnley, Yorks.
May 16, 1889		Sykes, Walter J., M.D., 8, Nicosia-road, Wandsworth-common, S.W.
Feb. 19, 1891		Symes, K. Edward, 9, Milton-road, Fitzburgh, Southampton
June 17, 1880		Symons, Brenton, 11, Parade, Truro, Cornwall
Dec. 17, 1874		‖Symons, William Henry, F.R.M.S., 130, Fellows-road, South Hampstead, N.W.
Feb. 17, 1881	Trans.	‖Takamatsu, T., Tokio University, Japan
Feb. 3, 1887	Trans.	Takamine, Jokichi, 1,0 Chicago, 2111, N. Jefferson-street, Peoria 111, U.S.A.
Feb 19, 1874		Tanner, Henry, Prof., 27, Mornington-crescent, Stanwick-road, West Kensington, W.
Feb. 21, 1884		Tarn, Albert, Mansion House-chambers, 20, Bucklersbury, E.C.
Dec. 4, 1890		Tate, Francis Henry, 9, Hackins Hey, Liverpool
June 16, 1881		Tate, George, Ph.D., College of Chemistry, Duke-street, Liverpool
Dec. 18, 1884	Trans.	‖Tate, Walter, 43, Norwood Grove, Liverpool
May 15, 1890		Tate, William, Royal College of Science, South Kensington, S.W.
Dec. 5, 1867		Tatlock, Robert R., Observatory, 2, Mundonald-road, Glasgow
Dec. 2, 1875		Taylor, Andrew, 11, Lutton-place, Edinburgh
Feb. 7, 1878		Taylor, G. S., 13, Queen's-terrace, St. John's-wood, N.W.
Dec. 7, 1882		Taylor, G. Midgley, 27, Great George-street, Westminster
June 17, 1880		‖Taylor, James, B.Sc., Government Metallurgist, Department of Mines, Sydney, New South Wales
June 18, 1891		Taylor, John, 15, Lucius-street, Torquay
April 19, 1888	Trans.	Taylor, John G., Orielton-terrace, Pembroke
Jan. 15, 1874		Taylor, R. L., 37, Mayfield-road, Whalley Range, Manchester
Dec. 6, 1888		Taylor, William, China Sugar Refining Co., East Point, Hong Kong
April 4, 1878		‖Tcherniac, Joseph, Ph.D., Thalstrasse 1, Freiburg, Briesgau, Germany
April 17, 1879	Trans.	Teed, Frank L., D.Sc., 15, Victoria-street, S.W.
May 1, 1877		Terrill, William, 42, St. George's-street, Swansea
Feb. 15, 1881		Tervet, Robert, 54, Penshurst-road, South Hackney, E.
June 18, 1891		Tetley, Frederick, 3, Mannville-terrace, Horton-road, Bradford

Date of Election.		
Feb. 16, 1893		Thackrah, James R., M.A., Ph.D., Technical Schools, Tavistock-road, Plymouth
Dec. 18, 1884		Thom, George, Dollar, N.B., and 48, Stanford-road, Victoria-road, Kensington, W.
Nov. 17, 1859		‖Thomas, Andrew, 13, Hendley-street, Adelaide, South Australia
Dec. 7, 1871		‖Thomas, Charles, Woodcote, Stoke Bishop
Mar. 5, 1874		Thomas, Harry Edgcombe, Rockleaze Point, Clifton, Bristol
Feb. 18, 1875	Trans.	‖Thomas, Joseph William, Drumpellier, Brunswick-road, Gloucester
Feb. 5, 1863		‖Thompson, Beeby, 55, Victoria-road, Northampton
June 15, 1893		Thompson, Frank Ernest, 97, Murdock-road, Handsworth, Birmingham
May 5, 1892		Thompson, George-de-Roos, 17, Tanfield-street, Leeds
May 4, 1893		Thompson, George R., The Laboratory, 57, Dock-street, Newport, Mon.
Dec. 16, 1886		Thompson, W. Phillips, 95, Shrewsbury-road, Claughton, Birkenhead
Dec. 17, 1885	Trans.	Thomson, Andrew, D.Sc., 10, Pitcullen-terrace, Perth
Mar. 4, 1886	Trans.	‖Thomson, Claude M., M.A., University College, Cardiff
Nov. 2, 1876	Trans.	Thomson, George C., 23, Kersland-terrace, Hillhead, Glasgow
April 15, 1858	Trans.	‖Thomson, John, 12, Lower Kennington-lane, S.E.
Jan. 18, 1872	Trans.	Thomson, John Millar, King's College, W.C.; and 53, Princes-square, Bayswater, W.
Jan. 18, 1872		Thomson, William, Royal Institution Laboratory, Manchester
Feb. 16, 1882	Trans	Thorne, Leonard T., Ph.D., 8, Dynevor-road, Richmond, Surrey
Dec. 3, 1885		Thorne, Edward E. H., care of H. E. Thorne, Esq., Bridgetown, Barbadoes, West Indies
Nov. 20, 1890		Thornley, J., Brooks, junr., c/o Felton, Grimwash, and Co., Jeffcott street, Melbourne, Australia
Dec. 3, 1891		Thorp, Walter, The Limes, Henry-road, New Barnet, N.
Feb. 1, 1866	Trans.	‖Thorp, William, B.Sc., 24, Crouch Hall-road, Crouch End, London, N.
Feb. 16, 1871	Trans.	†Thorpe, T. E., Ph.D. (Heid.), B.Sc. (Vict.), D.Sc. (Dubl.), F.R.S., Inland Revenue, Somerset House, W.C.
Dec. 7, 1893		Thorpe, Joselyn Field, Neuenheimer, Landstrasse 12, Heidelberg
May 7, 1891		Thonger, C. G. Freer, M.R.A.C., Colonial College, Hollesley Bay, Suffolk
Dec. 2, 1875	Trans.	Thresh, J. C., D.Sc., Medical Officer of Health, Chelmsford
Dec. 20, 1860	Trans.	Thudichum, John L. W., M.D., 11, Pembroke-gardens, W.
Dec. 2, 1880		Thwaite, B. H., Moorfields Chambers, 95 and 97, Finsbury-pavement, E.C.

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† Longstaff Medallist, 1881.

Date of Election.		
Feb. 19, 1863	Trans.	Tichborne, C. R. C., Ph.D., 15, North Great George-street, Dublin
Mar. 17, 1881	Trans.	Tiemann, Ferdinand, Prof., Dr. Parkstrasse, Wannsee, Berlin
June 1, 1865	Trans.	Tilden, William A., Prof., F.R.S., 77, Harborne-road, Edgbaston, Birmingham
Dec. 5, 1889	Trans.	||Tingle, J. Bishop, Ph.D., Gordon's College, Aberdeen
May 7, 1891		Tocher, James Fowler, A.I.C., 1, Chapel-street, Peterhead
June 20, 1853		||Tomlin, Andrew, Valparaiso
June 2, 1864	Trans.	Tomlinson, Charles, F.R.S., 7. North-road, Highgate, N.
June 17, 1880	Trans.	Tompkins, H. K., B.Sc., 52, Whiteley-road, Gipsy Hill, S.E.
Feb. 21, 1884		||Tompson, Frederick William, 1, St. Mildred's-road, Ramsgate
June 21, 1877		||Toms, Frederick Woodland, F.I.C., States Analyst, Jersey
Jan. 15, 1855		||Tookey, Charles, Museum of Practical Geology, Jermyn-street, S.W.
Dec. 3, 1868	Trans.	Tosh, Edmund G., The Lund, Ulverston, Lancashire
Feb. 16, 1893		Towers, John William, Victoria-road, Widnes
Feb. 2, 1888		Townsend, Charles F., 31, Elms-road, Clapham Common, S.W.
Feb. 18, 1892		Travers, Morris W., 2, Phillimore-gardens, Kensington, W.
Feb. 15, 1894		Trench, George, Cotton Powder Co., Faversham
Mar. 15, 1888		||Trewby, Herbert, Radnor House, Ribblesdale-road, Hornsey, N.
June 16, 1881		Trigger, Oliver, Chemical Department, Royal Arsenal, Woolwich, S.E.
Nov. 15, 1888		Trinks, C. Heinrich, 40, Ainger-road, Primrose Hill, N.W.
Dec. 4, 1873		||Truman, Edgar Becket, M.D., 31, Derby-road, Nottingham
Dec. 5, 1889		Tucker, Willis G., M.D., Albany, New York, U.S.A.
May 5, 1892		Tuer, Arthur Holt, Thornhill, Wigan, Lancashire
Dec. 2, 1886		Turner, Arthur, L.D.S. Ed., The Limes, Aylesbury
Dec. 6, 1888	Trans.	Turner, Charles, 225, Oxford-street, Manchester
Feb. 1, 1883	Trans.	||Turner, Thomas, County Offices, Stafford
Feb. 21, 1889	Trans.	Turpin, George Sherbrooke, M.A. (Cantab), D.Sc. (Lond.), Storey Institute, Lancaster
Dec. 15, 1892		Turton, Albert Henry, F.R.G.S., Ashleigh, Carlyle-road, Edgbaston, Birmingham, and Launceston, Tasmania
Feb. 2, 1871		||Tustin, John Robt., The Elms, Merton Hall-road, Wimbledon, S.W.
Feb. 2, 1888	Trans.	Tutton, Alfred E., Royal College of Science, South Kensington
June 19, 1879		Tweedie, George R., Little, Puckerstones, near Sturry, Kent
May 5, 1892		Tweedie, Thomas Shortridge, The Moat, Anan
Dec. 2, 1886		Twining, Alfred H., The Knoll, Salcombe, Kingsbridge, South Devon
Feb. 17, 1876		Typke, P. G. W., Ravenhurst, Morbiton Park, New Malden, Surrey
Dec. 7, 1876		Tyrer, Thomas, Stirling Chemical Works, Abbey-lane, Stratford
Dec. 3, 1885		Tyson, Thomas B., Cawnpore Chemical Works, D. Waldie and Co., Nawabgunge, Cawnpore, India

Date of Election.		
April 6, 1876		‖Udall, Thomas Bertram, Newcastle-under-Lyme, Staffordshire
Nov. 16, 1865		Umney, Charles, 50, Southwark-street, S.E.
Feb. 16, 1893	Trans.	Umney, John C., 50, Southwark-street, London, S.E.
Feb. 21, 1889		Underhill, Thomas J., 6, The Terrace, Royal Victoria Yard, Deptford, S.E.
June 3, 1869		‖Vacher, Arthur, 9, Marlborough-hill, St. John's Wood, N.W.
Mar. 16, 1882		‖Vacher, Francis, Birkenhead
Mar. 6, 1890		Valentin, Basil William, Messrs. Buckley Bros., Brewery, Llanelly, S. Wales
June 15, 1893		Vantin, Claude T. J., 42, Old Broad-street, E.C., and 3, Upper Hamilton-terrace, N.W.
Dec. 1, 1887		‖Vargas, Vergara J. M., Laboratorio Central, Calle 13, No. 206, Bogota, Republic of Columbia, South America
Mar. 1, 1883		Vasey, S. A., Arncliffe, Leytonstone, Essex
Dec. 7, 1882		Vasey, Thomas E., 6, South-parade, Leeds
April 17, 1879	Trans.	Veley, Victor H., M.A., 22, Norham-road, and University Museum, Oxford
Feb. 19, 1891		Velling, F. W. De, B.A., Upper Board Schools, Heckmondwike
May 6, 1881		Venable, Frank P., Ph.D., Chapel Hill, North Carolina
Jan. 17, 1889		Venis, Walter, M.R.C.S., L.S.A., D.P.H. Cantab., Benares, India
Jan. 18, 1872		Vincent, Charles W., F.R.S.E., F.C.S. of Berlin, Reform Club, Pall Mall, S.W., and Royal Institution, W.
May 16, 1889		Virtue, William, Abbey-street and Waterside Distilleries and Mills, Londonderry
Feb. 21, 1884		‖Voelcker, Edward William, Essex Villas, Kensington, W.
Jan. 17, 1884		‖Voelcker, John A., Ph.D., 20, Upper Phillimore-gardens, Kensington, W.
April 17, 1862		Von Bose, C. Moritz, Messrs. Gehe and Co., Chemical Works, Dresden
April 4, 1889		‖Voss, Walter Arthur, 159, Croydon-road, Anerley, S.E.
Nov. 19, 1885		Vulte, Hermann T., Ph.B., School of Mines, Columbia College, East 49th-street, corner of 4th-avenue, New York
Feb. 6, 1890		Wade, John, B.Sc. (Lond.), 15, St. George's Mansions, Bloomsbury, W.C., and Guy's Hospital, S.E.
June 7, 1888		Wade, Mark S., M.D., Victoria, British Columbia
Dec. 4, 1890		Wadsworth, George Henry, Fritham, near Lyndhurst, Hants
April 17, 1884		Wainwright, Howard, Ph.D., 22, West 46th Street, New York, City, U.S.A.
Feb. 16, 1893		Wait, Chas. E., Prof., University of Tennessee, Knoxville, U.S., N.A.

Date of Election.		
May 17, 1888		Wait, Frank Goodell, Geological Survey Department, Ottawa
Dec. 7, 1893		Walden, William Herbert, 55, Clapham-road, S.W.
Feb. 15, 1866	Trans.	Walenn, W. H., 9, Carleton-road, Tufnell Park, N.
Feb. 16, 1893		Walke, Willoughby, 1st Lieut., Fort Monroe, Virginia, U.S., N.A.
Mar. 17, 1881		Walker, Archibald, B.A., 8, Crown-terrace, Dowanhill, Glasgow
Feb. 2, 1865	Trans.	‖Walker, J. F., M.A., 45, Bootham, Yorks; and Sidney College, Cambridge
Jan. 16, 1868		Walker, Col. Alexander, R.A., Inspector-General of Ordnance, Calcutta
Dec. 5, 1889		Walker, Daniel, A.K.C., B.Sc., School of Mines, Ballarat, Victoria
Feb. 6, 1890	Trans.	‖Walker, James, D.Sc., 5, Chepstow-place, Westbourne Grove
April 17, 1890		Walker, James S. H., Earlybank, Perth
Dec. 6, 1888		Walker, J. T. Ainslie, The Laboratory, Rishton Paper Mills, near Blackburn, Lancashire
Feb. 17, 1881		Walker, Robert William, Bank Cottage, Edgworth, near Bolton
April 17, 1879		Walker, Thomas Hatfield, 1, Picton-place, Newcastle-on-Tyne
June 4, 1884		Wallace, Prof. Robert, The University, Edinburgh
Dec. 5, 1878	Trans.	‖Waller, Elwyn, Ph.D., School of Mines, Columbia College, cor. 49th-street, 4th-avenue, New York
Mar. 3, 1887		Wallis, Henry Weston, 8, Great Winchester-street, London, E.C.
Mar. 1, 1883		Walmsley, R. Mullineux, D.Sc., Heriot Watt College, Edinburgh
Dec. 6, 1888		Walrond, Edward Dalrymple, B.A., North Eastern Counties School, Burnard Castle, Durham
Mar. 20, 1884		‖Walton, Thomas Ulrick, B.Sc., F.I.C., Colonial Sugar Refinery Co., Sydney, New South Wales
April 21, 1864		Ward, George, Buckingham-terrace, Headingley, Leeds
Dec. 3, 1891		Ward, Thomas Armistead, 62, King William-street, Blackburn
April 20, 1871		Ward, William, Sheffield Moor, Sheffield
Dec. 4, 1873	Trans.	Warden, C. J. H., Prof. of Chemistry, Medical College, Calcutta
May 20, 1875		Wardle, Thomas, F.G.S., Leek, Staffordshire
Mar. 19, 1863	Trans.	Warington, Robert, F.R.S., Harpenden, St. Alban
June 15, 1893		Warmington, Edward A., Ph.D., Castle-street, Dudley
Dec. 7, 1871	Trans.	Warner, George Joseph, 41, Albert-road, Widnes
May 5, 1891		Warren, Cyprian A., 5, Cambridge-gardens, North Kensington, W.
Dec. 6, 1888		Warrick, Frederic Walmsley, 59, Great Ormond-street, W.C.
Nov. 17, 1887	Trans.	Warrington, Arthur Walley, University College of Wales, Aberystwith
Nov. 16, 1882		Waterfall, Charles J., Clyde Park, Bristol
April 4, 1889		Waterhouse, Wm. John, B.Sc., Christ Church, Oxford
Mar. 15, 1888		Wates, Edward Arthur, Secunderhabad, Deccan, India
Mar. 5, 1885		Watson, Charles, Walsden Chemical Works, near Todmorden
Jan. 18, 1872		Watson, David, D.Sc., The Broughton Copper Works, Salford, Manchester
June 16, 1887		Watson, Frederick Percy, 6 and 7, Bailgate, Lincoln

Date of Election.		
May 4, 1882		Watson, George, jun., 16, East Nelson-street, Whitevale, Glasgow
Mar. 1, 1883		‖Watson, Thomas Donald, 23, Cross street, Finsbury, E.C.
Jan. 20, 1876	Trans.	‖Watson, W. H., Braystones, near Whitehaven, Cumberland
June 21, 1877		Watt, Alexander, c/o Messrs. Macfie and Sons, 34, Moorfields, Liverpool
Mar. 1, 1883	Trans.	Watts, Francis, Government Laboratory, St. John's, Antigua, West Indies
Feb. 1, 1872	Trans.	‖Watts, John, D.Sc., Chemical Laboratory, Museum, Oxford
Dec. 5, 1878	Trans.	Watts, John I., Fairleigh, Hartford, Cheshire
Dec. 6, 1888		Way, Edward J., F.I.C., Eastleigh Syndicate, Box 84, Keerksdorp, Transvaal, South African Republic
June 6, 1872		Weaver, Richard, C.E., The Sanitary Laboratory, 87, Oxford-street, W.
Mar. 1, 1883	Trans.	Webster, Charles Stuart, Malvern House, Redland, Bristol
Mar. 1, 1866		Webster, G. W., 33, Bridge-street-row, Chester
June 21, 1877		Webster, William, Glencot, Blackheath Park, Blackheath, S.E.
April 4, 1889		Weir, P. A., Surgeon-Major, M.B., Residency Surgeon, Nepal, *viâ* Bombay
Feb. 16, 1888		Welch, J. Cuthbert, Messrs. Simonds, The Brewery, Reading
Dec. 7, 1893		Welchman, Frank Ernest, 16, Carlton-road, Putney Hill, S.W.
Feb. 19, 1891		Wellington, Stephen N., M.I.C.E., Gas Works, Norwich
May 5, 1892		Wells, George I. J., F.I.C., 47, Parkgate-road, Chester
June 19, 1884	Trans.	Wells, James S. C., Ph.D., Hackensack, New Jersey, U.S.A.
Feb. 6, 1890		Wells, S. Russell, B.Sc., M.B., Girdlers-road, West Kensington
Feb. 18, 1888	Trans.	Werner, Emil A., 5, Church-avenue, Rathmines, Dublin
Dec. 15, 1892		Westaway, Frederick William, B.A., Senior Boys' School, Dalton-in-Furness
Dec. 17, 1874	Trans.	Wethered, Edward, 4, St. Margaret's-terrace, Cheltenham
Dec. 6, 1883		Wetzel, Henry A., Messrs. Parke, Davies, & Co., Box 470, Detroit, Michigan, U.S.A.
Mar. 4, 1886		Wertheimer, Julius, Merchant Venturers' School, Bristol
May 5, 1892		Whalley, Lawrence J. de Lancaster, 26, Park-place, Greenwich, S.E.
June 15, 1893		Whalley, Sydney, 38, Havelock-street, Canterbury
Feb. 16, 1893		‖Wheeler, William Ernest, Cumberland-house, Meynell-road, South Hackney, N.E.
Dec. 6, 1888		Whieldon, Ernest William, 12, Bedford-road, Tottenham, N.
June 2, 1851		White, Alfred, F.L.S., West Drayton
Feb. 16, 1893		White, H. C., Prof., Athens, Georgia, U.S., N.A.
Dec. 3, 1891		White, Henry, Berlin-terrace, London-road, Carlisle
Mar. 20, 1862		White, Leedham, 2, Lime-street-square, E.C.
April 4, 1889		‖White, John Tsawoo, M.A., F.I.C., Treasury Office, Myaungmya, Myaungmya District, Lower Burmah
Dec. 7, 1893		White, William Gilchrist Lamb Roe, Whalley, near Blackburn
Feb. 5, 1885		Whitehead, Henry H., The Royal Brewery, Brentford

Date of Election.		
Dec. 5, 1889		Whitehouse, William, Albany House, Bradmore, Wolverhampton
Dec. 15, 1892		Whiteside, John Lowe, 51, Cannon-street, Bolton
Nov. 5, 1863		Whitfield, John, 113, Westborough, Scarborough
June 16, 1892		Whiteley, Fred., B.A., Alexandra-terrace, Bridgwater
April 15, 1886	Proc.	Whiteley, R. Lloyd, University College, Nottingham
Dec. 15, 1881		Whitlock, James, Sunny Bank-villas, Oswaldtwistle, Lancashire
April 17, 1879		Whitaker, Thorp, Messrs. Ripley & Sons', Dye Works, Bradford, Yorkshire
June 15, 1893		Whittaker, Thomas, 76, Arden-terrace, Accrington
Dec. 5, 1889		Whittam, Matthew, The Isle of Wight College, Ryde
Dec. 5, 1889		Wigan, Basil P., North Cheshire Brewery Company, Macclesfield, and 43, Christ Church-square, Macclesfield
May 7, 1891		Wild, John, 28, Hyde-road, Woodley, Stockport
June 16, 1881		Wilkes, John Potter, Pinner's Hall, 54½, Old Broad-st., E.C.
Feb. 19, 1891		Wilkinson, David, the University, Dunedin. Otago, New Zealand
May 4, 1893		Wilkinson, John, Drighlington, near Bradford
Dec. 17, 1885		Will, Wm. Watson, 1, St. Agnes-place, Kennington Park, S.E.
Feb. 19, 1891		Will, W., Ph.D., Beethhoven strasse, No. 1, Berlin, N.W.
Jan. 16, 1862	Trans.	||Williams, C. Greville, F.R.S., F.I.C., Castlemaine, Oakhill-road, Putney, S.W.
Dec. 15, 1892		Williams, John, Government Laboratory, British Guiana
June 21, 1883	Proc.	Williams, Rowland, Laboratory and Assay Office, 28, Pall Mall, Manchester, and Sunny Lea, Aldcliffe-road, Lancaster
June 18, 1891		Williams, Seward W., c/o Seabury and Johnson, 8, Brighton-avenue, East Orange, New Jersey, U.S.A.
Dec. 5, 1872		||Williams, Thomas, Chemical Laboratory and Assay Office, A, Queen Insurance-building, 10, Dale-street, Liverpool
Mar. 5, 1885		||Williams, Walter Collingwood, B.Sc., 68, Grove-street, Liverpool
Feb. 19, 1874	Trans.	||Williams, W. Carleton, Firth College, Sheffield
Dec. 15, 1892		Williams, William, County Offices, Westgate-street, Cardiff
Feb. 7, 1878		Williams, W. J., 1412, Van Buren-street, Wilmington Del., U.S.A.
Feb. 15, 1894		Williams, W. Lloyd, Erbistock, 10, Miskin-road, Dartford, Kent
May 15, 1848	Trans.	||Williamson, A. W., LL.D., F.R.S., High Pitfold, Haslemere
Dec. 4, 1874	Trans.	||Williamson, Robert, Low Walker, Newcastle-on-Tyne
Mar. 4, 1886	Proc.	Williamson, Sidney, The Mason College, Birmingham
June 15, 1871		Willmore, Charles, Queenwood College, near Stockbridge, Hants
Dec. 5, 1872		Wills, Jos. Lainson, care of A. Wells, Esq., 8, Honeywell-road, Wandsworth-common, S.W., and 106, Sparks-street, Ottawa, Canada
Dec. 2, 1875		Wills, Samuel Day, 11, Upper Belgrave-road, Clifton, Bristol
Dec. 5, 1889		Wilkie, John, M.D., 20, Buckingham-street, Strand, W.C.
Dec. 5, 1892		Wilsmore, N. Y. M., Altona, Orrong-road, Elsternwick, Melbourne

Date of Election.		
Feb. 5, 1885	Trans.	Wilson, A. C., Chemical Laboratory, Exchange-buildings, Stockton-on-Tees
June 19, 1879		‖Wilson, Charles J., 19, Little Queen-street, Westminster
June 21, 1883	Trans.	‖Wilson, David, jun., Carbeth, Killearn, by Glasgow
Nov. 19, 1855		Wilson, G. F., F.R.S., Heatherbank, Weybridge-heath
Dec. 18, 1879		Wilson, J. Millar, Norwich, Conn , U.S.A.
April 1, 1875		‖Wilson, James, M.A., Barrister-at-law, 2, Essex-court, Temple, and 23, Aberdeen-road, Highbury. N.
May 16, 1878		‖Wilson, James Henry, 6, Fenchurch-buildings, E.C.
Dec. 3, 1891		Wilson, John Henry, A.I.C., 29, Radford-street, Coventry
Dec. 7, 1871		Wilson, William John, 6, Malden-road, Watford
Dec. 17, 1885		Wilson, William M., The Limes, Hurstpierpoint, Hassocks, Sussex
Nov. 20, 1890		Wilson, J. Mitchell, M.D., Medical Officer of Health, Doncaster
Dec. 5, 1889		Wiltshire, J., Shire Hall, Hereford
Feb. 5, 1874		Wiltshire, Thomas Pemberton, care of New York Tartar Company, 9th Street and Gowan's Canal, Brooklyn, New York
Dec. 18, 1884		Wilton, Thomas, The Gas Light and Coke Co., Beckton, North Woolwich
Dec. 1, 1887		Winder, Bartlett W., Sunny Bank House, 43, Broomhall place, Sheffield
Dec. 7, 1893		Winder, Edward Humphreys, 37, Vincent-square, London, S.W.
Mar. 16, 1876		Winser, Percy James, Wyck House, Bebington, near Birkenhead
Nov. 19, 1885		‖Winstone, Arthur B., 7, Gray's Inn-square, W.C.
Mar. 2, 1857		Winstone, Benjamin, M.D., 100, Shoe-lane, E.C.; and 53, Russell-square, W.C.
Dec. 3, 1891		Winterton, A. W., 6, Linden-terrace, Rotherham
June 15, 1876	Trans.	Witt, Otto N., Ph.D., 33, Lindenallée, Westend, Charlottenburg, near Berlin
Dec. 5, 1867		Wood, Augustus A., 74, Cheapside, E.C.
April 4, 1889		Wood, Charles, 5, Wood-view, Bradford, Yorks
Jan. 19, 1860	Trans.	‖Wood, Charles Henry, Portland Villa, Drightstone-road, Addlestone, Surrey
Jan. 20, 1876		Wood, G. W., A.K.C., Metropolitan Board of Works, S.W. ; and Riggindale-road, Streatham, S.W.
Dec. 7, 1876		Wood, John, Portland-villa, Troon, N.B.
Dec. 4, 1890		Wood, Sidney, 5, Woodview, Bradford, Yorkshire
Dec. 18, 1884		Wood, William H., B.A. (Oxon.), La Martinière, Calcutta
Feb. 19, 1880		Wood, W. H., 3, New-road, Halifax
Dec. 7, 1871	Trans.	Woodcock, Reginald C., The American and Continental Sanitation Company, 636 to 642, West 55th-street, New York
Feb. 18, 1892		Woods, Hugh, 11, Archway-road, Highgate, London, N.

Date of Election.		
April 19, 1888		Woodward, James, B.A., F.I.C., B.Sc., 144, Osborne-road, Forest Gate, E.
April 4, 1889		Woolf, Mortimor, 16, Greville-place, N.W.
Dec. 6, 1889		Woosnam, Richard W., 28, Oaklands-road, Cricklewood, N.W.
Nov. 19 1885		Wormley, Theodore G., M.D., University of Pennsylvania, Department of Medicine, Philadelphia
Dec. 18, 1884		||Worrall, J. Hall, F.I.C., 158, Ellesmere-road, Sheffield
Feb. 4, 1858	Trans.	||Worsley, Philip J., Rodney Lodge, Clifton, Bristol
June 7, 1866	Trans.	Wright, Charles R. A., D.Sc., F.R.S., St. Mary's Hospital, Paddington, W.
Feb. 21, 1878	Trans.	Wright, Lewis Thompson, 1169, Calle Alsina, Buenos Ayres
Mar. 4, 1886		Wright, William T., 8, Grange-crescent. Sheffield
Feb. 4, 1864		Wrightson, John, Charford House Salisbury
Feb. 19, 1891		Wyatt, Thomas M., Chemical Department, Royal Arsenal, Woolwich, S.E.
Dec. 2, 1880		Wyborn, John Middleton, 26, Widmore-road, Bromley, Kent
Nov. 20, 1884		||Wyley, W. Fitzthomas, Wheatley-street, Coventry
May 7, 1885	Trans	Wynne, W. P., D.Sc., Royal College of Science, South Kensington, and 35, Parson's-green, Fulham, S.W.
June 4, 1874	Trans.	Yates, Robert, 64, Park-street, Southwark
Dec. 16, 1886		Yoshida, H., Science College, Imperial University, Tokyo, Japan
Feb. 5, 1885		Young, Alfred C., 64, Tyrwhitt-road, St. John's, S.E.
Mar. 4, 1886		||Young, Brougham, Home Lyn, Woodberry Down. London, N.
Mar. 15, 1877		Young, Frank W., High School, Dundee, and Woodmuir, West Newport, Fife, N.B.
Dec. 4, 1890		||Young, George, Ph.D., Firth College, Sheffield
June 21, 1877		Young, J. Rymer, 42, Sankey-street, Warrington
Feb. 5, 1874		Young, John, 2, Montague-terrace, Kelvinside, Glasgow
June 16, 1887	Trans.	Young, John William, B.Sc., B.A., Analyst's Office, Great Northern Railway Plant, Doncaster, and 25, Hall Gate, Doncaster
Feb. 16, 1882	Trans.	||Young, Sydney, D.Sc., F.R.S., University College, Bristol, and 13, Aberdeen-terrace, White Ladies'-road, Bristol
Nov. 6, 1873		||Young, W. C., 22, Windsor-road, Forest-gate, Essex
April 4, 1878		Zingler, Maximilian, 19, Buckland-crescent, Belsize-park, N.W., and 16, Fenchurch-street, E.C.

FOREIGN MEMBERS.

NUMBER NOT TO EXCEED FORTY.

Date of Election.	
May 18, 1876	Baeyer, Adolph von, F.R.S., University of Munich
Feb. 1, 1883	Beilstein, Prof. F., Ph.D., Technological Institute, St. Petersburg
Mar. 1, 1860	Berthelot, M., F.R.S., Collège de France, Paris
Feb. 2, 1888	Boisbaudran, Lecoq de, 36, Rue Prony, Paris
Feb. 1, 1842	Bunsen, R. W., Ph. D., F.R.S., University of Heidelberg
June 19, 1862	*Cannizzaro, S., Senato di Roma
Feb. 1, 1883	Cleve, Prof. P. T., Ph.D., University, Upsala, Sweden
May 18, 1876	Cooke, Josiah P., Harvard University, Cambridge, Massachusetts, U.S.
Feb. 1, 1883	Erlenmeyer, Prof. E., Ph.D., Frankfurt-on-Main
June 16, 1892	Fischer, Emil, Ph.D., University of Berlin
Feb. 1, 1883	Fittig, Prof. R., Ph.D., University, Strassburg
Nov. 4, 1844	Fresenius, C. Remigius, Ph.D., Wiesbaden
May 18, 1876	Friedel, C., École des Mines, Paris
May 3, 1866	Gibbs, Prof. Wolcott, Cambridge, Massachusetts, U.S.
June 16, 1892	Graebe, Carl, Ph.D., University of Geneva
Feb. 1, 1883	†Helmholtz, Prof. H. von, F.R.S., Neue Wilhelmstrasse, 16, Berlin, N.W.
Feb. 2, 1888	Hoff, Prof. J. H. van't, Ph.D., 103, Stadtonderskade, Amsterdam
June 19, 1862	Kekulé, Prof. A., F.R.S., University of Bonn
Feb. 2, 1888	Ladenburg, Prof. A., Ph.D., Kaiser Wilhelmstrasse, 43, Breslau
Feb. 2, 1888	Landolt, Prof. H., Ph.D., Königgrätzerstrasse, 123B, Berlin, W.
June 16, 1892	Lieben, Adolph, Ph.D., University of Vienna
Feb. 1, 1883	‡Mendeléef, Prof. D., Ph.D., University, St. Petersburg

* Faraday Lecturer, 1872.

† Faraday Lecturer, 1881.

‡ Faraday Lecturer, 1889.

Date of Election.	
Feb. 1, 1883	Meyer, Prof. Lothar, Ph.D., University, Wilhelmstrasse, 9 Tübingen, Germany
Feb. 1, 1883	Meyer, Prof. Victor, Ph.D., University of Heidelberg
Feb. 2, 1888	Nilson, Prof. L. F., Ph.D., Albano, Stockholm
June 19, 1862	Pasteur, L., F.R.S., L'Institut Pasteur, Paris
Mar. 1, 1860	Peligot, E., à la Monnaie, Paris
May 3, 1866	Rammelsberg, Prof. C. F., Berlin
June 16, 1892	Schiff, Hugo, Ph. D., University of Florence
June 16, 1892	Schlœsing, Th. Ph.D. Institut Agronomique, Paris
May 18, 1876	Thomsen, Prof. Julius, Ph.D., University of Copenhagen
Feb. 2, 1888	Wislicenus, Prof. Johannes, Ph.D., University, Leipzig

FARADAY LECTURERS.

1869.	J. B. A. Dumas.
1872.	S. Cannizzaro.
1875.	A. W. von Hofmann.
1879.	A. Wurtz.
1881.	H. von Helmholtz.
1889.	D. Mendeléef.

LONGSTAFF MEDALLISTS.

1881.	T. E. Thorpe, F.R.S.
1884.	C. O'Sullivan, F.R.S.
1888.	W. H. Perkin, F.R.S.
1891.	F. R. Japp, F.R.S.
1894.	H. T. Brown, F.R.S.

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PROCEEDINGS

OF

THE CHEMICAL SOCIETY.

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JANUARY—DECEMBER, 1895.

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DATES OF ISSUE OF THE MONTHLY NUMBERS OF THE JOURNAL OF THE CHEMICAL SOCIETY TO FELLOWS.

January number was issued		10th January.
February	,,	15th February.
March	,,	9th March.
April	,,	9th April.
May	,,	7th May.
June	,,	1st June.
July	,,	11th July.
August	,,	9th August.
September	,,	7th September.
October	,,	10th October.
November	,,	2nd November.
December	,,	24th December.

LIST OF GRANTS MADE FROM THE RESEARCH FUND DURING THE YEAR.

£30 to Messrs. J. J. Hummel and A. G. Perkin, for the investigation of certain natural colouring matters.

£10 to Dr. H. Ingle, for the purchase of various aldehydes, ketones, and hydrazine to continue his work on stereoisomeric osazones.

£10 to Dr. J. J. Sudborough, to continue his work on diorthosubstituted benzoic acids.

£15 to Mr. E. Haworth, for the synthesis of an acid having the composition $C_8H_{14}(COOH)_2$, and the comparison of its properties with those of camphoric acid.

£5 to Mr. R. E. Doran, for a research on the preparation of mustard oils by the reaction of chlorocarbonic esters with lead thiocyanate.

£15 to Dr. W. A. Bone, to continue a research on the substituted succinic acids, and on the behaviour of various trimethylene compounds on treatment with the sodium compound of ethylic malonate.

£10 to Dr. B. Lean, to extend his work on the derivatives of ethylic butane tetracarboxylate.

£20 to Dr. J. Walker, for an investigation of the conditions of equilibrium between the cyanates and the corresponding ureas.

£10 to Mr. A. E. Tutton, for the purchase of chemicals to continue his investigations on the relationship between the chemical composition of crystallised substances and the characters of their crystals.

£20 to Dr. J. F. Thorpe, to continue his research on the two methylisopropylsuccinic acids, and the isomeric $\beta\beta$-trimethylglutaric acid.

£15 to Dr. F. D. Chattaway, for a research on the quaternary hydrazines.

£10 to Messrs. C. F. Cross and Claude Smith, for the purchase of materials in connection with investigations of natural oxycelluloses and carbohydrates of barley straw.

£10 to Mr. J. E. Marsh, to continue work on camphene derivatives in particular with regard to the products of oxidation and substitution.

LIST OF FELLOWS ELECTED DURING 1895.

Name.	Proposed.	Elected.
Anderson, Herbert	December 20th, 1894	February 21st.
Arnot, John Melrose	November 16th, 1894	,, ,,
Auden, Harold Allden	March 21st	May 16th.
Bailey, George Percy, B.A.	June 6th	December 5th.
Barralet, Edgar S.	April 25th	May 16th.
Berkeley, The Earl of	November 7th	December 5th.
Blume, Eugen	February 7th	May 16th.
Borradaile, L. A., B.A.	March 21st	,, ,,
Bradford, Henry	,, ,,	,, ,,
Bruckmann, Gustav T., B.Sc.	April 25th	,, ,,
Butler, David Butler	December 6th, 1894	February 21st.
Carr, Francis H.	December 20th, 1894	,, ,,
Case, Thomas Bennett, B.A.	January 17th	,, ,,
Chapman, Arthur Jenner	November 7th	December 5th.
Chattaway, William	,, ,,	,, ,,
Cheadle, Walter W., B.A.	April 25th	May 16th.
Coblentz, Virgil, Ph.G., A.M., Ph.D.	February 7th	,, ,,
Cockburn, George Bertram	June 20th	December 5th.
Cook, Herbert William, B.Sc.	February 21st	May 16th.
Crocker, Charles	June 20th	December 5th.
Crossman, Tom	December 6th, 1894	February 21st.
Croysdale, John	May 16th	June 20th.
Cuthbertson, Gurney	June 20th	December 5th.
Daw, Frederic W.	December 6th, 1894	February 21st.
Dixon, William	June 20th	December 5th.
Druce, Edric	February 21st	May 16th.
Elliott, Edward	November 16th, 1894	February 21st.
Engineer, K. S.	April 25th	May 16th.
Entroppe, Arthur T.	,, ,,	,, ,,
Fairrie, Henry	January 17th	February 21st.
Farr, Edward H.	June 20th	December 5th.
Fauvel, Charles J.	,, ,,	,, ,,
Fawns, Sydney	April 25th	May 16th.
Fielding, Joseph D.	June 20th	December 5th.
Foakes, Jervis E.	May 16th	,, ,,
Foster, Hasslewood J.	March 21st	May 16th.
Fox, Stanley	May 16th	December 5th.
Fuerst, Alexander F., Ph.D.	April 25th	May 16th.
Gardner, Herbert E.	January 17th	February 21st.
Gardner, James	June 20th	December 5th.
Gerrans, Henry T., M.A.	January 17th	February 21st.
Gilbard, J. F. H.	February 7th	May 16th.
Goddard, William	April 25th	,, ,,
Goldfinch, George	January 17th	February 21st.
Graham, Edward, B.Sc.	June 20th	December 5th.
Grant, D. St. John, M.A., M.B.	December 20th, 1894	February 21st.

Name.	Proposed.	Elected.
Grant, Patrick H.	April 25th	May 16th.
Greaves, William A.	,, ,,	,, ,,
Grime, Herbert	December 20th, 1894	February 21st.
Grossmann, Edward H.	June 20th	December 5th.
Gunn, Alexander	February 7th	May 16th.
Hall, Henry A., The Rev.	June 6th	December 5th.
Haller, H. Loft	February 21st	May 16th.
Hanes, Edgar S.	June 20th	December 5th.
Hanson, Weldon	December 6th, 1894	February 21st.
Harris, Harry	November 16th, 1894	,, ,,
Harris, Walter, B.A., Ph.D.	December 6th, 1894	,, ,,
Harrison, C. E., B.A.	June 20th	December 5th.
Hastings, Hugh	December 6th, 1894	February 21st.
Hatfield, J. Adams	,, 20th, 1894	,, ,,
Henderson, James, B.Sc.	June 6th	December 5th.
Heriot, T. H. P.	,, 20th	,, ,,
Hill, Edward H.	January 17th	February 21st.
Hillard, F. A., B.A.	June 20th	December 5th.
Holme, Arthur E., M.A.	,, ,,	,, ,,
Hudson, Percy	December 20th, 1894	February 21st.
James, Alfred	June 20th	December 5th.
Johnson, F. E.	,, ,,	,, ,,
Jones, Evan L., B.A.	February 7th	May 16th.
Joseph, Edgar	January 17th	February 21st.
Kenyon, Richard E., B.Sc.	November 16th, 1894	,, ,,
Kibble, W. O.	June 20th	December 5th.
Kingdon, G. H., B.A.	November 16th, 1894	February 21st.
Kinnicut, Leonard P.	June 20th	December 5th.
Kirkaldy, P. H.	December 20th, 1894	February 21st.
Lones, Joseph	May 16th	June 20th.
Macfarlane, Alexander	November 16th, 1894	February 21st.
Marchant, R. C.	March 21st	May 16th.
Marsden, P. H.	,, 7th	,, ,,
Marshall, Arthur	November 16th, 1894	February 21st.
McCreath, James	June 20th	December 5th.
McGlashan, John	February 7th	May 16th.
McVey, Wm. B.	December 20th, 1894.	February 21st.
Meldrum, Robert	January 17th	,, ,,
Morgan, D. J.	June 20th	December 5th.
Morrell, R. S., M.A., Ph.D.	March 7th	May 16th.
Newton, C. B.	April 25th	,, ,,
Niblett, H. E., B.A.	January 17th	February 21st.
Offord, James A.	December 6th, 1894	,, ,,
Patterson, Lama G.	March 7th	May 16th.
Pennington, W. H.	June 6th	December 5th.
Potter, Arthur E.	May 16th	June 20th.
Powell, H. J.	January 17th.	February 21st.
Priest, Martin	June 20th	December 5th.

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Read, E. J., B.A.	May 16th	June 20th.
Ridge, W. T. B.	June 6th	December 5th.
Robinson, H. L.	January 17th	February 21st.
Round, William	June 20th	December 5th.
Rugginz, W. A.	,, 6th	,, ,,
Seyler, Clarence A., B.Sc.	,, 20th	,, ,,
Sharrott, T. C.	December 6th, 1894	February 21st.
Shaw, G. E.	February 21st	May 16th.
Slocum, Frank L.	April 25th	,, ,,
Smith, Mathew, B.A.	June 20th	December 5th.
Squance, T. E., M.D., M.S.	February 7th	May 16th.
Stansfield, Alfred, B.Sc.	April 25th	,, ,,
Stephens, Frank R.	June 20th	December 5th.
Stephenson, Frederick	December 20th, 1894	February 21st.
Stone George	June 20th	December 5th.
Le Suer, Henry R., B.Sc.	January 17th	February 21st.
Theodosius, Alfred F., B.A.	February 7th	May 16th.
Thomson, W. T.	April 25th	,, ,,
Thornton, Arthur, M.A.	,, ,,	,, ,,
Tibbals, W. J.	June 20th	December 5th.
Treharne, F. G.	March 7th	May 16th.
Ward, G. J.	February 7th	,, ,,
Warrington, Thomas C.	December 20th, 1894	February 21st.
Warwick, A. W.	March 7th	May 16th.
Whiston, W. A.	April 25th	,, ,,
Wigley, Henry F. A., B.A.	March 21st	,, ,,
Williams, D. J.	December 6th, 1894	February 21st.
Williams, Evan	,, ,, ,,	,, ,,
Williams, John, B.A.	June 20th	December 5th.
Wilson, Harry	January 17th	February 21st.
Wilson, John, B.Sc.	April 25th	May 16th.
Wingfield, T. R.	June 20th	December 5th.
Wright, Harold E.	,, 6th	,, ,,
Young, H. S.	December 20th, 1894	February 21st.

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Name.	Elected.	Died.
Davy, S. H. M.	June 15th, 1893	May 28th, 1895.
Galloway, R.	December 20th, 1847	January 15th, 1896.
Kelly, Jno. Abr.	May 3rd, 1894	
Liepmann, Henry, Ph.D.	April 15th, 1880	
Linford, J. S.	March 5th, 1874	October 30th, 1895.
Looker, Percy	December 15th, 1881	
McRoberts, George	February 18th, 1882	January 15th, 1896.
Offord, James A.	December 6th, 1894	March, 1895.
Pochin, H. D.	April 1st, 1858	October 28th, 1895.
Smith, C. H.	February 15th, 1894	April 26th, 1895.
Smith, Miles H.	February 6th, 1873	

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ERRATA.

Page	Line	
80	13	*for* "disulphonic" *read* "dichlorosulphonic."
84	25	,, "product by" *read* "product is obtained by."
84	26	,, "of" *read* "by."
162	23	,, "production" *read* "reduction."
206	19	,, "camphoric" *read* "camphoic."
209	36	,, "bromo-nitro camphor" *read* "dibromonitro camphor."

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PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

EDITED BY THE SECRETARIES.

No. 146. Session 1894–95.

January 17th, 1895. Dr. Armstrong, President, in the Chair.

Messrs. Cecil Cooke Duncan and Robert W. Buttermer were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Thomas Bennett Case, B.A., 82, James Street, Dublin; Henry Fairrie, 63, Parkfield Road, Liverpool; Herbert Edward Gardner, Lyonsdown Vicarage, New Barnet; Henry Tresawna Gerrans, M.A., 20, St. John Street, Oxford; George Goldfinch, Hendon, N.W.; Edgar Joseph, 42, Brondesbury Road, Kilburn, N.W.; Henry R. Le Sueur, B.Sc. (Lond.), Chemical Laboratory, St. Thomas's Hospital, S.E.; Robert Meldrum, 27, Lansdowne Road, S.W.; Henry Edward Niblett, B.A., Eldon Lodge, Hewlett Road, Cheltenham; Harry James Powell, 530, Lordship Lane S.E.; Herbert Lewin Robinson, 9, Lloyd Street, W.C.; Harry Wilson, 146, High Street, Southampton.

The certificate of the following candidate, proposed by the Council under Bye-law 1 (3), was also read:—

Edward Herbert Hill, Colonial Bank of New Zealand, Dunedin.

The following is the text of the letter which has been received from Professor Remigius Fresenius, acknowledging the address recently presented to him by the Society:—

"Wiesbaden, den 6ten Januar 1895.

"An den Vorstand der Chemical Society of London.

"Sie haben mir durch Übersendung des prachtvollen Diploms, welches mir in Erinnerung bringt, dass ich seit 50 Jahren die Ehre

habe Mitglied Ihrer hochangesehenen und hochachtbaren Gesellschaft zu sein, eine grosse Freude bereitet. Das Diplom, am 24ten December des verflossenen Jahres abegesandt, wurde mir am 28ten December, als an meinem 76ten Geburtsfeste, überreicht. Gestatten Sie, dass ich Ihnen für die mir gewordene Auszeichnung meinen herzlichsten Dank sage.

"Wenn man auf die 50 Jahre zurückschaut, welche zwischen meinem Aufenthalt im Liebig'schen Laboratorium in Giessen und der Gegenwart liegen, und die ausserordentlichen Fortschritte in's Auge fasst, welche die Chemie in allen ihren Gebieten und welche im Zusammenhange damit die chemische Industrie gemacht hat, so kann man diess nur mit Stolz und grosser Freude thun, denn Zeiten grösseren Aufschwungs hat keine andere Wissenschaft zu verzeichnen, und wenn man sich vergegenwärtigt, dass dieser Aufsschwung dem Zusammenwirken der Forscher der verschiedenen Culturvölker zu verdanken ist, so gereicht diess zu besonderer Genugthuung. Ist es doch in Wahrheit eine Freude sagen zu können, es gibt noch Gebiete, auf denen die Nationen sich nicht bekämpfen, sondern auf denen sie sich zur Förderung gemeinsamer Interessen und zur Erreichnung gemeinsamer Ziele freundlich die Hände reichen.

"Es war mir vergönnt an der Lösung der Aufgaben der Chemie 5 Decennien hindurch mitwirken zu können und ich freue mich dessen von ganzem Herzen, und wenn ich auch jetzt den Fortschritten der Wissenschaft nicht mehr in allen ihren Theilen zu folgen vermag, so bin ich doch aufrichtigen Dankes voll, dass mir immer noch Lust, Liebe und auch eine gewisse Kraft geblieben ist in meinem 77ten Lebensjahre an der Förderung der analytischen Chemie mitarbeiten zu können.

"Ihr schönes Diplom schliesst mit dem freundlichen Wunsche, dass mir diese Mitarbeit noch langere Zeit vergönnt sein möge und verpflichtet mich hierdurch noch zu ganz besonderem Dank.

"Ich wünsche der Chemical Society stets Wachsen und Gedeihen und bitte meiner auch fernerhin freundlich zu gedenken.

"Mit vorzüglicher Hochachtung,

"C. R. FRESENIUS."

Of the following papers those marked * were read.

*1. "Octacetylmaltose." By Arthur R. Ling and Julian L. Baker.

Octacetylmaltose, $C_{12}H_{14}(OC_2H_3O)_8O_3$, is obtained by boiling maltose with acetic anhydride and anhydrous sodium acetate (Liebermann's method). It crystallises from alcohol in magnificent long, prismatic needles, melts at 158—159° without decomposing, is

sparingly soluble in cold alcohol, readily so in benzene, glacial acetic acid, and hot alcohol, and extremely soluble in chloroform, but insoluble in water. Its specific rotatory power in chloroform is $[\alpha]_D = +62·22$ (mean of two observations), and in alcohol (two observations) $[\alpha]_D = +59·31$. No birotation was observed. The compound has no taste. Herzfeld (*Ber.*, **13**, 267; *Annalen*, **220**, 215) has described an octacetylmaltose, prepared by the same method. He states that it crystallises from alcohol in colourless prisms, melting at 150—155° but decomposing, that it has a bitter taste, is insoluble in chloroform, and has a specific rotatory power in alcohol $[\alpha]_D$ $+81·8$. The authors, therefore, conclude that Herzfeld's description of the compound is in many respects erroneous.

*2. "Action of diastase on starch." By Arthur R. Ling and Julian L. Baker.

The authors have carried out numerous experiments in order to prove the existence or otherwise of Lintner's so-called isomaltose, which is said to be one of the products of the hydrolysis of starch (*Ber.*, **26**, 2538). As the result of a study of the action of precipitated diastase (prepared from low-dried distillers' malt by Lintner's method) on starch, they have isolated a very hygroscopic substance having, roughly speaking, the same properties as Lintner's supposed compound, thus: $[\alpha]_D$ 143, and R (= per cent. of maltose) = 81·5. This substance gave numbers on analysis agreeing with the formula $C_{12}H_{22}O_{11}$, and cryoscopic determinations seemed to point to this as the molecular formula. A microscopic examination of the substance showed, however, that it contained crystals resembling maltose, and it yielded nearly half its weight of octacetylmaltose on acetylation. Treated with diastase, the reducing power was raised to R = 94·6, but the sp. gr. of the solution before and after treatment remained unaltered, a point to which Hiepe has drawn attention. It was found to ferment but slowly with ordinary beer yeast, the unfermented residue being unaltered in properties. The osazone was separable into a large fraction melting at 182—185° which resembled maltosazone in appearance, and a very small fraction melting at 145—152°. The authors suggest tentatively, that the substance may possibly contain the simple dextrin $C_{12}H_{20}O_{10} + H_2O$, a view which derives some support from the fact that the sp. gr. of a solution remains unaltered after being submitted to the action of diastase.

When starch paste is treated at 70° with the diastase obtained from pale brewers' malt, which is dried at a much higher temperature than that manufactured for distillers, the alcoholic extract of the product yields, on treatment with phenylhydrazine, a small quantity of glucosazone, and an osazone which, when repeatedly recrystallised from hot water, has all the properties of Lintner's so-called isomaltosazone: thus, it crystallises in nodular groups of extremely minute, yellow needles, and melts at 150—153°. On analysing this substance, it gave the numbers of a *triosazone.* The mean analytical values are found: $C = 52\cdot73$; $H = 6\cdot20$; $N = 8\cdot31$ per cent. The formula $C_{12}H_{20}O_9(N_2HC_6H_5)_2$ requires $C = 52\cdot78$; $H = 6\cdot15$; $N = 8\cdot21$ per cent.

The authors are therefore inclined to conclude that a triose, $C_{18}H_{32}O_{16}$, is one of the products of the action of diastase on starch, and are now attempting its isolation.

DISCUSSION.

Mr. HORACE T. BROWN expressed satisfaction that the question of the hydrolysis of starch was once more attracting the attention of English chemists. The authors' recent work promised to be a valuable contribution to the subject. As the speaker and Dr. Morris are at the present time engaged in a thorough reinvestigation of the chemistry of starch hydrolysis, he could not say much about it on this occasion, but hoped to lay their results before the Society at no far distant date.

It was satisfactory that the authors had been able to confirm the existence of the maltodextrin described by Dr. Morris and himself. It has recently been urged by Lintner that this is not a pure substance, but a mixture of his "isomaltose" with the dextrins; such, however, is not the fact. Whilst admitting that every credit is due to C. J. Lintner for first calling attention to the fact that amongst the products of starch hydrolysis there is a substance other than maltose, producing a definite and crystallisable osazone, there was no doubt in the spaker's mind that Lintner was mistaken both as to the constitution and properties of the substance in question, and he agreed so far with the authors of the paper that Lintner's isomaltose was not a chemical entity. He was not prepared, however, to admit the triose nature of the substance yielding the osazone described, and could not regard the mere analysis of the osazone as a proof of this.

*3. "New derivatives from α-dibromocamphor." By Martin O. Forster, Ph.D.

Among the many well-known peculiarities displayed by derivatives of camphor is the fact that whilst monobromocamphor is readily acted on by somewhat dilute nitric acid, being in part converted into a nitro-derivative and in part oxidised to camphoric acid, α-dibromocamphor (m. p. 61°) is unaltered by acid of the strength which at once attacks the mono-derivative, although its conversion into monobromocamphor is readily effected by digestion with alcoholic potash. At Dr. Armstrong's suggestion the author has extended the study of dibromocamphor in the hope of explaining its relationship with monobromocamphor, and at the same time of throwing further light on the nature of camphor itself. The experiments form part of a comprehensive series now being carried on in the Central Technical College Laboratory with the object of investigating the behaviour of the substituted derivatives of camphor generally.

Whereas dilute nitric acid is without action on α-dibromocamphor, spontaneous development of heat is observed to attend its dissolution in the fuming acid (d. 1·52), the action culminating at about 70° in brisk evolution of red fumes. The chief product is a colourless solid, which crystallises from alcohol in long, prismatic needles melting at 152°. On analysis this has given the following results: Carbon, 36·86 and 36·95; hydrogen, 4·38 and 4·36; bromine, 49·13, 49·50, and 49·20,—the values calculated for the formula $C_{10}H_{12}Br_2O_2$ being 37·03 carbon, 3·70 hydrogen, and 49·38 bromine, it seems probable that by the action of nitric acid two atoms of hydrogen in dibromocamphor are displaced by an atom of oxygen. The substance is neutral in character, and does not appear to be acted on either by phenylhydrazine or by hydroxylamine; hot sodium ethoxide converts it into a substance soluble in alkalis, which does not contain bromine.

When the solution of the new derivative in hot alcohol is digested with zinc dust and ammonia it is reduced. The product crystallises in thin, lustrous, hexagonal plates melting at 159°. On analysis it is found to contain 48·81 carbon, 6·08 hydrogen, 32·44 bromine; the values calculated for $C_{10}H_{13}BrO_2$ being 48·98 carbon, 5·30 hydrogen, 32·65 bromine. This compound has phenolic properties, and forms a dark green, crystalline copper salt, but remains unchanged when heated on the water bath with acetic anhydride and sodium acetate. Sodium ethoxide has no action on it; on treatment with bromine it is reconverted into the original dibromo-compound (m. p. 152°).

On adding fuming nitric acid to the solution of the monobromoderivative in glacial acetic acid, the liquid acquires a green colour, and on warming it a violent action is set up, red fumes being evolved. In this way a nitro-derivative is obtained crystallising in colourless needles which melt at 125°, containing carbon, 40·82; hydrogen, 4·82; bromine, 29·70; nitrogen, 5·56. The values calculated for $C_9H_{12}BrO{\cdot}NO_2$ being 41·22 carbon, 4·58 hydrogen, 30·53 bromine, and 5·34 nitrogen, it appears that, simultaneously with nitration, elimination of a carbonyl group has taken place, a change which is in some respects comparable with the formation of sulphocamphylic acid from camphoric acid. When this nitro-compound is reduced in alcoholic solution with zinc dust and ammonia, bromine is eliminated, and a colourless nitrogenous substance is formed, crystallising from boiling water in lustrous laminæ which melt at 159—162°.

A remarkable feature of the change undergone by α-dibromocamphor in contact with fuming nitric acid, is the formation of a small quantity of ordinary monobromo-camphor melting at 76°.

It is proposed to study the behaviour of other camphor derivatives, especially bromochlorocamphor and dichlorocamphor, towards nitric acid. From the former a new substance has already been obtained, together with monobromocamphor. The new product crystallises in fine silky needles melting at 143·5° ; on reduction it yields a phenolic, monohaloïd derivative from which it may be reproduced by bromination. The description of these compounds is reserved for a later communication, together with the products of the sulphonation of α-dibromocamphor, which, it is found, may be effected without difficulty.

*4. "Acid sulphate of hydroxylamine." By E. Divers, M.D., F.R.S.

The author has prepared crystalline hydroxylamine hydrogen sulphate, NH_2OH,H_2SO_4, by acting on solid hydroxylamine hydrochloride with the calculated quantity of sulphuric acid. When the first action is over, the product is heated during several hours at 100° to expel hydrogen chloride, and the cold viscid liquid left in a desiccator until it has set to a translucent mass of prismatic crystals. These, after drying on a porous tile, were analysed, and furnished results agreeing with those calculated from the formula.

*5. "The hypophosphites of mercury and bismuth." By S. Hada.

Attempts to prepare a mercurous hypophosphite were unsuccessful. By acting on a solution of mercuric or mercurous nitrate with potassium hypophosphite, a white, unstable precipitate of the double mercurous nitrate and hypophosphite, $HgH_2PO_2,HgNO_3,H_2O$, is obtained. This salt explodes when heated above 100°.

Bismuth hypophosphite, $Bi(H_2PO_2)_3,H_2O$, is readily prepared by adding a solution of bismuth nitrate to a solution of potassium hypophosphite. It is a white, crystalline powder, which is fairly stable when dry. When strongly heated, this salt decomposes in accordance with the equation $3Bi(H_2PO_2)_3 = 2Bi + Bi(PO_3)_3 + 6P + 9H_2O$.

6. "Kamala. Part II." By A. G. Perkin.

The three acids melting respectively at 282°, 226°, and 232°, produced by the action of nitric acid on rottlerine (Trans., 1893, 982), have been prepared in larger quantity and re-examined, with the result that they were found to contain nitrogen, and to consist of *ortho*- and *paranitrocinnamic* acids and *paranitrobenzoic acid*. *Paranitrobenzaldehyde* was also isolated from among the products of this action. Paranitrobenzoic acid, also obtained in a similar way from the resins of high and low melting points and isorottlerine (Trans., 1893, 986, 989, 990), results evidently from the oxidation of the paranitrocinnamic acid which is first formed.

Crystalline metallic compounds of rottlerine have been prepared having respectively the formulæ $C_{33}H_{29}O_9Na$, $C_{33}H_{29}O_9K$, $(C_{33}H_{29}O_9)_2Ba$, $(C_{33}H_{29}O_9)_2Pb$, and $C_{33}H_{29}O_9Ag$, showing that rottlerine must be represented as $C_{33}H_{30}O_9$, or three times the formula $C_{11}H_{10}O_3$ originally assigned to it by Anderson (*Edin. New. Phil. J.*, 1, 300). These results point also to the probability that rottlerine is a monobasic acid, $C_{32}H_{29}O_7 \cdot COOH$.

When boiled with sodium carbonate solution rottlerine is decomposed yielding, together with resinous products, a substance crystallising in garnet-coloured prisms, to which the formula $C_{29}H_{26}O_6$ has been provisionally assigned. It is insoluble in aqueous alkalis, except in presence of alcohol. For this substance the name *rottlerone* is proposed.

7. "The action of aqueous potassium cyanide on gold and silver in presence of oxygen." By J. S. Maclaurin, B.Sc., University College, Auckland, New Zealand.

This is a continuation of a paper (Trans., 1893, 724—738) in which the interaction of gold and potassium cyanide—the basis of the now extensively applied Mac Arthur-Forrest or Cassell process—was investigated.

Further results are quoted proving the necessity of oxygen. The rate of dissolution of gold in potassium cyanide solutions is reinvestigated, and that of silver is also determined. The rate of dissolution increases as the concentration of the solution decreases, reaching a maximum when solutions containing 0·25 per cent. are used, and then decreasing. It is also shown that the ratio of the gold dissolved by any given cyanide solution to that of the silver dissolved by the same solution is approximately the ratio of their atomic weights. The remarkable variations in the solubility of gold and silver may be explained by the fact that the solubility of oxygen in cyanide solutions decreases as the concentration increases, and that the solvent power of the strong solutions is thus rendered less than that of the weaker solutions which are capable of taking up more oxygen. The relations of the gold, silver, and oxygen dissolved are shown in a table under headings $\frac{\mathrm{Au}}{\mathrm{O}}$ and $\frac{\mathrm{Ag}}{\mathrm{O}}$, and it is pointed out that if the amount of gold or silver dissolved depend solely on the quantity of oxygen in solution, the values $\frac{\mathrm{Au}}{\mathrm{O}}$ and $\frac{\mathrm{Ag}}{\mathrm{O}}$ should be constant; actually these values gradually decrease as the concentration of the solution increases. Therefore in the more concentrated solutions there is less metal dissolved than the amount of oxygen in solution apparently demands. This points to some retarding action on the motion of the oxygen molecules. As it seemed probable that viscosity would have such a retarding action, the rates of dissolution of gold and silver were determined in cyanide solutions rendered more viscous by the addition of various substances such as sugar and glycerol which might be assumed to exert no chemical influence on the solubility of these metals. The results show that the assumption is correct. Moreover, the viscosity coefficients of cyanide solutions of varying strengths were determined, and the values $\frac{\mathrm{Au}}{\mathrm{O}}$ and $\frac{\mathrm{Ag}}{\mathrm{O}}$ were calculated by the aid of a formula previously given; these agree very closely with those found, showing that the rates of dissolution of gold and silver are proportional to the amount of oxygen in solution and to the coefficient of viscosity.

8. "The crystalline form of the isomeric dimethylpimelic acids." By William J. Pope.

In order to obtain confirmatory evidence of the distinct nature of the two dimethylpimelic acids isolated by Dr. Kipping, a crystallographic examination of the two products was undertaken.

The acid melting at 81—81·5°—paradimethylpimelic acid—crystallises on spontaneous evaporation of its aqueous solution in minute, colourless rhombohedra belonging to the monosymmetric system, and showing the forms $c\ \{001\}$, $a\ \{100\}$, and $m\ \{110\}$; in one case a face of the form $p\ \{11\bar{1}\}$ was observed; $a:b:c = 1{\cdot}263:1:1{\cdot}062$. $\beta = 43°\ 23'$. It sometimes crystallises in flat rhomboidal plates showing the forms $c\ \{001\}$, $p\ \{11\bar{1}\}$, and $p'\ \{111\}$, which have the same crystalline form as the rhombohedra.

The acid melting at 76—76·5°—antidimethylpimelic acid—crystallises from its aqueous solution in small orthorhombic prisms showing the forms $m\ \{110\}$ and $p\ \{101\}$; $a:b:c = 0{\cdot}821:1:2{\cdot}862$. A well-defined orthorhombic interference figure of large axial angle is seen through the face *p* (101); the optic axial plane is parallel to *b* (010).

The crystallographic comparison of the two acids thus confirms their chemical dissimilarity in the most striking way.

9. "Oxidising action of ammonia solution on some metals." By W. R. Hodgkinson and Lieut. N. E. Bellairs, R.A.

That an oxidation takes place when copper, moistened with ammonia solution, is placed in contact with air seems to be generally known (Schönbein, *Ber. Ak. B.*, 1856, 580; *J. B.*, **56**, 311; *Ann. Chim. Phys.*, [4], **1**, 381; Peligot, *Compt. rend.*, **47**, 1034).

Undoubtedly both copper and ammonia become oxidised in this case. As other metals dissolve to some extent in ammonia solution, the authors have determined whether any similar oxidation took place under ordinary conditions of temperature.

As might be expected, those metals which form soluble double salts with ammonium salts are most acted on by ammonia solution.

Zinc, nickel, and cobalt are, after copper, most rapidly attacked, a considerable amount of metal in each case being dissolved. Lead dissolves more slowly, and iron, magnesium, and aluminium do not appear to dissolve at all.

In the case of copper, the formation of nitrite is detectible after 10 minutes' contact of the metal and ammonia in presence of air. To make a comparative test, the metals mentioned were exposed in small pieces to ammonia solution and air in similar flasks covered only with watch glasses during 48 hours. They were then examined for nitrite or nitrate by (1) potassium iodide, (2) ferrous sulphate, and (3) naphthylamine sulphanilic acid.

Zinc, nickel, lead, magnesium, aluminium, iron, and palladium in foil failed to form any nitrite.

The nickel was obtained from nickel carbonyl. After more than a week's exposure to the ammonia, although it formed a deep blue solution, no trace of nitrite was found. Cobalt, however, even after 12 hours, afforded a very appreciable amount of nitrite, the amount appearing to increase regularly with the time of exposure.

10. "Action of magnesium on some phenylhydrazine compounds." By W. R. Hodgkinson and A. H. Coote.

In a note to the Society (Proc., 137, p. 80) the authors described very shortly the action of magnesium on phenylhydrazine.

This metal acts on the acid derivatives with less violence than on phenylhydrazine itself, but it is still energetic when the magnesium is employed in the form of filings.

Acetylphenylhydrazine, $C_6H_5NHNHCOCH_3$, melting at 128°, was mixed with magnesium filings and heated somewhat quickly in a retort to a little above its boiling point; there was considerable frothing and evolution of gases, which proved to be hydrogen and nitrogen; the water over which they were collected contained much ammonia. Other products, condensed before reaching the water, were benzene, aniline, acetanilide and ammonium acetate, with a little unchanged acetphenylhydrazine. The retort residue contained magnesium acetate, magnesium oxide, and some carbonaceous matter.

It seems probable that the first attack of the magnesium is on some of the acetyl groups, which thus furnish hydrogen, which, in turn, splits up other molecules of the acetylphenylhydrazine into aniline, benzene, &c.

The action is, therefore, somewhat different from that of the metal on phenylhydrazine.

Acetanilide, phthalanil, and several other anilides can be distilled over magnesium without appreciable action or change.

Benzoylphenylhydrazine behaves like the acetyl compound. The products of the action of magnesium are hydrogen, nitrogen, ammonia, benzene, aniline, and ammonium benzoate.

So far the amounts of *benzene*, *aniline*, and *acetanilide* obtained indicate that $4(C_6H_5NHNHCOCH_3)$ gives $2(C_6H_5NH_2) + C_6H_6 + C_6H_5NHCOCH_3 + 3NH_3$; the other products are still undetermined.

11. "Refraction equivalents of the elements and the periodic law." By R. M. Deeley.

In this paper it is shown that the refraction equivalents of the elements for the most part fall into line with the modified periodic arrangement of the elements, which the author has previously suggested (Trans., 1894).

At the next meeting on Thursday, February 7th, the following papers will be read:—

"The electromotive force of an iodine cell." By A. P. Laurie, M.A.

"The action of heat on ethylic β-amidocrotonate." By Dr. Collie.

"The acidimetry of hydrofluoric acid." By Professor Haga.

CERTIFICATES OF CANDIDATES FOR ELECTION AT THE NEXT BALLOT.

N.B.—The names of those who sign from "General Knowledge" are printed in *italics.*

Anderson, Herbert,

County School, Wellington, Somerset.

Science Teacher. National Scholar, 1884–88. A.R.C.Sc., London, in Chemistry and Physics. Headmaster, Torquay School of Science, 1890–93. Science Master, Somerset County School, since 1893.

T. E. Thorpe. C. H. Bothamley. Chapman Jones.
A. E. Tutton. F. R. Japp.

Arnot, John Melrose,

The Bally Paper Mills, Calcutta; 10, Park Road, Trinity, Edinburgh.

Chemist and Paper Maker. From 1886 till 1890 Student of Chemistry at Heriot-Watt College, Edinburgh, holding Prize and Certificates of College and Science and Art Department, South Kensington. Recently Chemist to Ottoman Paper Manufacturing Co., Limited, Constantinople. In 1890 I revised and republished in the *Paper Trade Review* my father's (late W. Arnot, F.C.S., &c.) 1877–78 Cantor Lectures, "The Technology of the Paper Trade."

W. H. Perkin, Jun. David Paterson.
John Hunter. *Stevenson Macadam.*
W. Ivison Macadam. *James Stenhouse.*

Butler, David Butler,

41, Old Queen Street, Westminster, S.W.

Civil Engineer, Cement Expert, and Chemist. Member of Society of Engineers. 1881–84, Pupil with the late Henry Faija, M.Inst.C.E. (Cement Expert, Author of "Portland Cement for Users" [Weale's Series], and various papers, &c.). 1884–87, Assistant in Mr. Faija's Laboratory. 1887–90, entire charge of Mr. Faija's Laboratory. 1890–91, Chemist in charge of Manufacture at Folkestone Cement Works. 1892–94, Chemist in charge of Manufacture at C. Francis, Son, and Co., Newport, I.W. June, 1894, to August, 1894, in full charge of Mr. Faija's practice. Present time, in practice as Mr. Faija's successor as Civil Engineer, Cement Expert, and Analyst, under terms of an Agreement made with that gentleman, and since fully confirmed by his Executors.

Otto Hehner. E. G. Clayton. Edward D. Gravill.
L. W. Fulcher. William Tate. G. Stillingfleet Johnson.
Chapman Jones. *A. P. Hope.* *Wallace C. Nickels.*

Carr, Francis H.,

Meaburne, Warham Road, Croydon.

Salters' Company's Research Fellow in Chemistry, Research Laboratory, Pharmaceutical Society. Passed the Examination for the Associateship of the Institute of Chemistry. Three years' course in Chemistry, Finsbury Technical College. Two years in the Research Laboratory, Pharmaceutical Society. Joint Author with Professor Dunstan of papers on "Aconite Alkaloids" (*J. Chem. Soc.*, 1893–94).

Wyndham R. Dunstan. R. Meldola. Thomas S. Dymond.
H. A. D. Jowett. Martin O. Forster.

Case, Thomas Bennett,

82, James Street, Dublin.

Brewer to Messrs. Arthur Guinness, Son, and Co. B.A., Magdalen College, Oxford. Student of Chemistry.

A. Vernon Harcourt. John Conroy. William Odling.
W. W. Fisher. John Watts. V. H. Veley.

Crossman, Tom,

40, Coldhurst Street, Oldham.

Brewer and Chemist. Author of "The Analysis of Malt" (*J. Amer. Chem. Soc.*, **16**, No. 8). Head Brewer and Chemist at the Oldham Brewery Co., Limited. Consulting and Analytical Chemist to the Aleine Company, Hollinwood. Editor of the "Transactions" of the North of England Institute of Brewing. Twelve months Student under Mr. Trant. Two years with Dr. Hiepe, F.I.C.

William L. Hiepe, Ph.D., F.C.S., F.I.C.
Alex. K. Miller, Ph.D. J. M. Collett.
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Assistant Works Manager. Student at Yorkshire College, 1884–85. Four years Assistant Chemist, North-Eastern Railway Company's Laboratory, Gateshead-on-Tyne. Student with, and afterwards Assistant to, Dr. R. Fresenius, Wiesbaden, Germany. Four years Works Chemist with United Alkali Co. (Allhusen's Works). At present time Assistant Manager in Works of Reckitt and Sons, Limited, Hull.

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P. Phillips Bedson.
R. Routledge.
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Under-Manager at Messrs. Fairrie and Co., Limited, Sugar Refiners. For three years Student under Dr. Tate, Liverpool College of Chemistry, engaged in Chemical Bacteriological Investigation.

George Tate.
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Charles A. Kohn.
Joseph T. Freestone.
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Analytical Chemist, also Manufacturing Chemist. Engaged for past eight years in Chemical Industry and Investigation in Essential Oils Ethers, and the higher Alcohols. Contributed to the *Glasgow Herald*, on Sewage Precipitation, also fugitive pieces on various subjects to the *Glasgow News* and *Glasgow Evening Citizen.*

John R. Jackson.
Robert R. Tatlock.
Jas. Grant.
J. Buchanan.
Alexander M. Martin.
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Lecturer in Chemistry, &c., at the Agricultural College, Aspatria, Cumberland. Inter. Science, London University, 1892. Two years Student at University College, Gower Street, under Professor Ramsay and Dr. Collie. Two years Student at University College, Bangor, under Dr. Dobbie.

Arthur P. Luff.
W. Ramsay.
R. T. Plimpton.
J. Norman Collie.
E. Grant Hooper.
J. Woodward.
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Fellow, Mathematical Lecturer, and Tutor of Worcester College, Oxford. Being desirous of studying Stereochemistry from a mathematical standpoint, and having served as Examiner in the Final Honour School of Natural Science at Oxford.

William Odling.
John Watts.
W. W. Fisher.
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Goldfinch, George,

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Pharmaceutical Chemist. Member of the Pharmaceutical Society. Passed Major Examination, 1864. Attended the course of Lectures of the Pharmaceutical Society's School under Professors Bentley and Redwood.

M. Carteighe.
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A. E. Barclay.
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Sub-Inspector Science and Art Department Associate and Prizeman in Chemistry, Royal College of Science, London, 1891. Teaching Scholar, Royal College of Science, 1891–94. Assistant Examiner in Chemistry, Science and Art Department. Sole Lecturer and Demonstrator in Chemistry, Westbourne Park Institute (Session 1891–92), and Temporary Chief Lecturer and Demonstrator in Chemistry, People's Palace, 1894.

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Lowthian Bell.
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J. E. Stead.
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T. E. Thorpe.
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Senior Natural Science Master. As Student: Honourman of South Kensington; 1st B.Sc., London Uniuersity; late Scholar of St. John's College, Cambridge; B.A., 1st Class Natural Science Tripos, 1886. As Teacher: Late Assistant University Demonstrator in Biology (Cambridge); late Science Master of Heidelberg College, now of Campbell College, Belfast; Ph.D. (Heidelberg University). Paper contributed to *Berichte d. deutsch. Chem. Ges.*, jointly with Professor Victor Meyer, "Ueber den Molecularzustand der Calomeldampfes" (*Ber.*, 1894, **27**, 1482), also "Ueber die Dampfdichte des $HgCl_2$ und d. PCl_3 bei Temperatura über 1000° C." (*Inaug. Diss., Heidelberg*, 1894).

Professor Victor Meyer.
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Student, Royal College of Science, London. Associate of the Institute of Chemistry. Four years' Chemical study at Mason's College, Birmingham.

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Chemical Assistant. Studied Chemistry at the Cambridge University Laboratory. Attended lectures at King's College, London, on Bacteriology. Studied special Chemistry of Brewing under Matthews and Lott. At present engaged in research work under Matthews and Lott, Analytical Chemists, Burton-on-Trent. Holds 1st Class Certificate of City of London Guilds in Brewing.

W. J. Sell. H. J. H. Fenton. Thomas H. Easterfield.
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Assistant Demonstrator at Westbourne Park Institute Chemical Laboratory. Have studied Chemistry for five years. Hold 1st Class Advanced Practical and Theoretical Certificate from South Kensington. Assistant Demonstrator with Mr. Brown. At present doing special work in "Chemical Manipulation" for Honours Examination at Westbourne Park Institute.

Fredk. Wm. Brown. W. P. Hatton.
George Smith. *E. Francis Smith.*
Sidney Smith. *E. C. Conrad.*

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Science Master at Ashville College, Harrogate. Gained the Degree of B.Sc. (Honours Chemistry) of Victoria University. Late Scholar of University College, Liverpool.

J. Campbell Brown. Charles A. Kohn.
Herbert B. Stocks. J. Rymer Young.
W. Collingwood Williams. *G. T. W. Newsholme.*

Kingdon, George Holman,

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Senior Demonstrator in Chemistry at the Exeter Technical College. Three years' course at Merton College, Oxford, taking a 2nd Class in the Final Honour School of Chemistry.

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John M. Thomson.
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Herbert Jackson.
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Pharmaceutical Chemist. Professor of Chemistry, College of Physicians and Surgeons, Boston. Graduate New Brunswick, Canada Pharmaceutical Society, and Ontario College of Pharmacy, Toronto, Canada. Government Examiner in Chemistry to Pharmaceutical Society of New Brunswick, Canada, for two terms, three years each. Late of the Chemical Department, Boston Dental College. "Chemistry of the Creation"—"Chemical Importance of the Ptomains in Medico-legal Analysis."

Alfred H. Mason.
E. B. Shuttleworth.
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James H. Stebbins, jun.
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University Extension Lecturer. B.A. (Oxon). 1st Class Final Honour of Natural Science (Oxford, June, 1890). Late Natural

Science Scholar of Trinity College, Oxford. Formerly Royal Exhibitioner of the Science and Art Department. Associate of the Royal College of Science, Dublin. Lecturer on Chemistry and Agricultural Science to the Delegates of the Oxford University Extension and to the Somerset County Council. Late Lecturer to the County Council of Shropshire.

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Percy Elford.	A. Vernon Harcourt.
Frank Pullinger.	J. A. Gardner.

D. H. Nagel.

Offord, James Albert,

46, St. Giles Street, Norwich, now at Suva, Fiji.

L.R.C.P., London, 1889; M.R.C.S., England, 1889. Late House Surgeon, London Hospital, &c. Divisional Surgeon appointed by the Colonial Board. Desires admission as being interested in Chemistry in connection with Biological and Sanitary Science.

Francis Sutton.	F. Napier Sutton.
John R. Skelton.	*A. R. Golden.*

R. S. Cahill.

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David Howard.	W. J. Pope.
Gerald T. Moody.	*F. Stanley Kipping.*
Martin O. Forster.	*W. Palmer Wynne.*

Robinson, Herbert Lewin,

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Chemical Lecture Assistant, Guy's Hospital. Assistant in Chemical Laboratory of Guy's Hospital since January, 1892. Author of article "The Presence of Vanadium in Commercial Caustic Soda" (*Chem. News*, October 26, 1894).

Thos. Stevenson.	Charles E. Groves.
John Wade.	Norman Leonard.

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Student of the Royal College of Science, London. Associate of the

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A. E. Tutton. *William A. Tilden.*

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Chemical Laboratory, St. Thomas's Hospital, S.E.

Assistant Demonstrator of Chemistry, St. Thomas's Hospital Medical School. Studied Chemistry at University College, London, from 1889 to 1893. Bachelor of Science (London). A.I.C. (by examination). Joint Author with Dr. Collie of paper on the "Salts of Dehydracetic Acid" (*J. Chem. Soc.*, 1894).

Wyndham R. Dunstan. William Ramsay.
J. Norman Collie. R. T. Plimpton.
Walter H. Ince.

Warrington, Thos. C.,

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Student of Chemistry at University College, Aberystwyth, and at Jesus College, Oxford. B.A. Hons., Nat. Sci. (Chem.), Oxford, 1894. Now engaged in Chemical Work at the Museum, Oxford.

D. H. Nagel. W. W. Fisher.
V. H. Veley. J. E. Marsh.
J. A. Gardner. John Watts.

Williams, David John,

Ty Newydd Farm, Garn Dolbenmaen, Carnarvon.

Agricultural Chemist. Exhibitioner of the University College of North Wales, where I studied Agriculture and the allied Sciences for two Sessions. Studied Agriculture and Agricultural Chemistry at the Government Agricultural Institution, Glasnevin, Dublin. Since October, 1892, have studied at the Royal College of Science, South Kensington, and have completed the final courses in Agriculture and Agricultural Chemistry.

Chapman Jones. T. E. Thorpe. W. Palmer Wynne.
A. E. Tutton. James J. Dobbie.

Williams, Evan,

Rochdale Road Gas Works, Manchester.

Chemist and Gas Examiner. Chemist and Gas Examiner to the Manchester Corporation Gas Works during the last 13 years, during eight of which I was Assistant under the late Dr. John Leigh, M.R.C.S., Medical Officer of Health and Chemist to the Manchester Corporation.

S. H. M. Davy. F. Stanley Kipping.
Wilfrid Irwin. H. B. Dixon.
W. H. Perkin, jun.

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Manufacturing Pharmaceutical Chemist. Fellow of the Institute of Chemistry. Joint Author of "Proximate Analysis of *Colubrina Reclinata.*"

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Assistant in the Chemical Laboratory of Mr. G. H. Ogston. Studied at King's College, London, during the Sessions 1890–93. Daniell Scholar in Chemistry, 1893. Since that time Assistant in Messrs. Ogston and Moore's Laboratory.

John M. Thomson. Herbert Jackson.
G. H. Ogston. C. A. Mitchell.
Otto Hehner.

Proposed by the Council under Bye-law 1 (3).

Hill, Edward Herbert,

Colonial Bank of New Zealand, Dunedin.

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David Wilkinson, A.R S.M.

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Issued 18/2/1895.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

EDITED BY THE SECRETARIES.

No. 147. Session 1894–95.

February 7th, 1895. Dr. Armstrong, President, in the Chair.

Messrs. W. Herbert Walden, Robert H. Wilson and J. Young were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Eugen Blume, Russell Ho., Trinity, Edinburgh; Virgil Coblentz, Ph.D., M.A., 115 W. 68th Street, New York, U.S.A.; John Francis Hutchins Gibbard, 362 Mare Street, Hackney; Alexander Gunn, 66 Finsbury Park Road, N.; Evan Lewis Jones, B.A., 4 Bank Buildings, Llandilo; John McGlashan, Cawnpore Sugar Works, Cawnpore, India; Lama Gray Patterson, Washington, Pa., U.S.A.; Thomas Coke Squance, M.D., M.S., &c., 4 Beauclerc Terrace, Sunderland; Alfred F. Theodosius, B.A., Magdalen College School, Oxford; George John Ward, The Cottage, Hallam Fields, Ilkeston.

Of the following papers those marked * were read.

*12. "The action of heat on ethylic β-amidocrotonate. Part II." By J. Norman Collie, Ph.D.

In Part I of this paper, the author has shown that when ethylic β-amidocrotonate is heated it condenses to form a pyridine derivative, ethylic lutidone-monocarboxylate. He has since found that at least three other nitrogenous condensation products are formed when the amidocrotonate is destructively distilled.

The compound which is formed in largest quantity is ethoxylutidine ($\alpha\gamma$-dimethyl-α'-ethoxypyridine), $2C_6H_{11}NO_2 = C_9H_{13}NO + NH_3 + CO + CO_2 + C_2H_4$. It is a pleasant-smelling liquid, b. p.

217—218° (corr.). It forms a platinum salt, which melts at 226° (corr.) with much decomposition. When heated in a sealed tube with fuming hydriodic acid, ethylic iodide and pseudolutidostyril are produced.

A dimethylpyrrol is also formed in small quantities, $2C_6H_{11}NO_2 = C_6H_9N + 2CO_2 + 2C_2H_4 + NH_3 + H_2$. This dimethylpyrrol seems to be identical with one which was obtained by Ciamician and Wiedel by destructively distilling gelatine. Its boiling point lies between 170° and 175°. It has also been obtained by Knorr by reducing isonitroso-ethylic β-amidocrotonate.

A third substance has been isolated which is also doubtless a pyridine derivative. It is produced by the following reaction: $2C_6H_{11}NO_2 = C_6H_8N_2O + EtOH + CH_3COOEt$. When heated with zinc dust, it gives α-picoline. It contains a hydroxyl group, for it yields a monochloride with pentachloride of phosphorus. It is probably either α-methyl-γ-amido-α'-hydroxypyridine or α-methyl-α'-amido-γ-hydroxypyridine. It does not diazotise when acted on with fuming hydrochloric acid and sodium nitrite, but with nitrous fumes in aqueous solution it forms a curious addition product: $C_6H_8N_2O + NO_2 + H_2O = C_6H_{10}N_3O_4$.

*13. "The acidimetry of hydrogen fluoride." By T. Haga and Y. Osaka.

The authors have separately examined the behaviour of the usual indicators in the neutralisation of hydrofluoric acid. That its alkali salts blue litmus, and that its avidity number places it among the vegetable acids rather than with the strong mineral acids, appear to be the only two facts yet recorded bearing upon its acidimetry.

To get uniform indications it was found necessary to have not only the acid pure, but the titrating solutions also; a little silica, alumina, or carbon dioxide affecting the titration more than it would in the case of the ordinary mineral acids.

Phenolphthaleïn is the best indicator, and leaves nothing to be desired when potash or soda is used for the titration. *Rosolic acid* is almost equal to it, and can be used besides with ammonia. With both indicators the change of colour has the advantage of being very evident in platinum vessels.

Both *cochineal* and *brazil-wood* infusions give satisfactory results. Brazil-wood paper shows alkalinity before all the acid is neutralised, and cannot, therefore, be used. *Turmeric paper* gives fairly good results. *Methyl orange* is useless.

Litmus, *lacmoïd* and *phenacetolin* are all capable of being made to yield accurate results in the hands of an experienced person. Some peculiarities in the behaviour of litmus are described in the paper which suggest the conclusion that the molecule of hydrogen fluoride may be H_3F_3 or H_4F_4.

*14. "Composition of ancient silver ornaments from Peru." By Miss C. Walker.

The two ornaments examined were found in the ancient graves of Incas, at Chimbote, and they were analysed in the Chemical Laboratory of the University of Virginia. Both ornaments were covered by a thin crust, chiefly composed of silver chloride and a basic copper carbonate in the one case, and of cuprous oxide in the other. One ornament was a silver plate composed of 85·24 per cent. of silver, 13·96 per cent. of copper and 0·15 per cent. of gold. The other ornament was a ring, joined by soldering the ends of a flat metallic band. This consisted of 25·51 per cent. of silver, 72·09 per cent. of copper, 0·25 per cent. of gold, 1·21 per cent. of iron, 0·5 per cent. of zinc and about 0·1 per cent. of lead. The iron, lead and zinc were probably derived from the solder.

It would seem that these ornaments had been made from native silver.

*15. "Molecular change in a silver amalgam." By Miss F. T. Littleton.

When an amalgam of silver and mercury is moderately heated, considerable swelling takes place, suggestive of the escape of gas, and, on cooling, the pasty mass sets to a hard crystalline porous substance. The increase in volume is most considerable when the metals in the amalgam are present in the proportions corresponding with the formula $AgHg_4$.

On examining the action it is found that no appreciable quantity of gas escapes from the amalgam and the swelling must, therefore, be attributed to the molecular changes which accompany the union of the two metals.

16. "Sulphocamphylic acid. II." By W. H. Perkin, jun.

At the commencement of this investigation in 1891 a number of analyses of sulphocamphylic acid were carried out, as mentioned in the previous communication (Proc., 1893–94, p. 110), and the author then observed that at a temperature of 110—115° this acid has the composition $C_9H_{14}SO_5$ or $C_8H_{12}(SO_3H)\cdot COOH$, the crystals of the acid which separate from aqueous solution being $C_9H_{14}SO_5 + 3H_2O$; this observation has since been confirmed by Koenigs and Meyer (*Ber.*, 1894, 3466).

That this formula correctly represents the composition of sulphocamphylic acid is shown by the analysis of its sulphobromide,

$C_8H_{12}(SO_2Br)\cdot COOH$, which the author has succeeded in preparing by the interaction of the potassium salt of the acid and phosphorus pentabromide. This derivative crystallises from dilute methyl alcohol in prisms; it melts at 152°, and at a slightly higher temperature decomposes, evolving sulphur dioxide. By extracting the black residue with light petroleum, and recrystallising the product from formic acid, a colourless crystalline acid, $C_8H_{12}Br\cdot COOH$, is obtained $= C_8H_{12}(SO_2Br)\cdot COOH - SO_2$. This new acid melts at 130—132°, and is readily acted on by alcoholic potash, being converted into an acid of the composition $C_8H_{11}\cdot COOH = C_8H_{12}Br\cdot COOH - HBr$. This acid, which melts at about 105°, may possibly be identical with the acid of this composition (m. p. 108°), which is formed when sulphocamphylic acid is fused with soda (see below).

The author has continued his experiments on the fusion of sulphocamphylic acid with potash and soda, and finds that in all cases the product contains two isomeric unsaturated acids, $C_8H_{11}\cdot COOH$ (m. p. 108° and 148°), which can be separated only with great difficulty by recrystallisation, but which were finally obtained in a pure condition by taking advantage of the fact that the aqueous solution of the ammonium salt of the higher-melting acid dissociates readily at 80°, the acid separating, whereas the ammonium salt of the acid of melting point 108° remains unchanged at this temperature.

The acid melting at 148° has already been obtained by Kachler (*Annalen*, **169**, 133); it is readily acted on by bromine, hydrogen bromide being evolved, and is converted into a crystalline acid, $C_8H_{10}Br_3\cdot COOH$, which melts at 178°.

The isomeric acid melting at 108° is also readily attacked by bromine, but no hydrogen bromide is evolved, and it yields, on oxidation with permanganate, a syrupy hydroxy-acid.

A careful investigation of these new compounds, as well as of those mentioned in the previous communication is in progress.

17. "Derivatives of ethyl-orthotoluidine." By W. MacCallum, jun.

This paper contains an account of work conducted in the year 1893, at Mülhausen, by the late Mr. William MacCallum, jun. The account now given has been drawn up from Mr. MacCallum's notes by Dr. Hepburn. The object of the investigation was to ascertain whether nitrosoethyltoluidine and the diazoamido-derivatives of nitroethyltoluidine could be converted into ethylisindazole and nitroethylisindazole respectively. This proved not to be the case, but in the course of the investigation several new compounds were prepared, amongst them being *nitroethylorthotoluidine*, *ethyl toluylenediamine*, *nitroethylacetoorthotoluidine*, m-*nitroethylnitrosoorthotoluidine* and *ethyldiazoamidotoluene*. The last-named compound furnishes the same nitro-indazole as is formed by diazotising *m*-nitrotoluidine and heating the product with dilute sulphuric acid.

18. "Acetyl derivatives of benzaconine and aconitine." By Wyndham R. Dunstan, F.R.S., and Francis H. Carr.

The authors have made a number of experiments in the hope of being able to convert benzaconine into aconitine by introducing an acetyl group into it. These experiments have so far been unsuccessful, but several new compounds have been obtained, both from benzaconine and from aconitine, the analyses of which serve to further confirm the formulæ which the authors have previously proposed for these alkaloids, $C_{31}H_{43}NO_{11}$ and $C_{33}H_{45}NO_{12}$, whilst the analytical results do not bear out the formulæ proposed by Freund and Beck, $C_{32}H_{45}NO_{10}$ and $C_{34}H_{47}NO_{11}$. By acting on benzaconine dissolved in chloroform with acetic anhydride during 24 hours at the ordinary temperature an amorphous base is obtained which forms crystalline salts; the *hydrobromide* melts at 265°. The substance does not seem to be toxic. When hydrolysed by heating with water in a closed tube it furnishes acetic acid and benzaconine.

At 100°, or by Liebermann's method, a crystalline base (m. p. 255—256°) results from the action of acetic anhydride. On hydrolysis, this substance breaks up into aconine, benzoic acid, and 24·4 per cent. of acetic acid, proving it to be a *triacetyl benzaconine*. This derivative appears to be identical with that described by Freund and Beck as a monacetyl derivative. These observers do not appear to have estimated the amount of acetic acid produced on hydrolysis, but to have trusted to the results of combustions, which, as the authors have previously pointed out, furnish by themselves no safe criteria of composition with such compounds. This base also appears to be non-poisonous.

Acetyl chloride, acting in the cold on benzaconine dissolved in chloroform, produces a crystalline base (m. p. 162°), which forms crystalline salts, including an aurichloride. It also appears to be a *triacetyl benzaconine*, $C_{31}H_{40}(CH_3CO)_3NO_{11}$.

The further action of acetyl chloride on this substance, or on benzaconine, in a sealed tube at 100° C., results in the formation of a crystalline base (m. p. 211°), which appears to be *tetracetyl benzaconine*. It forms a remarkable colourless aurichlor-derivative (m. p. 225°).

Acetic anhydride does not act on aconitine.

Acetyl chloride forms *diacetyl aconitine* (m. p. 158°), which differs from its isomeride triacetyl benzaconine principally in its physiological action, which resembles that of aconitine, and also in the property of forming an aurichlor-derivative, as well as in its crystalline form.

Triacetyl aconitine (m. p. 206—207°) also differs from its isomeride tetracetyl benzaconine in its crystalline form and physiological activity.

Pyraconitine and acetyl chloride interact, forming a crystalline base (m. p. 203°), which is *triacetyl pyraconitine.* This substance does not seem to be poisonous. In determining the composition of each of these substances, reliance has been placed on the determination of the amount of acetic acid formed on hydrolysis. Combustions for carbon and hydrogen have also been made, and the results bear out the formula suggested by the authors for aconitine, and do not agree with the formula suggested by Freund and Beck, as will be seen from the following table, which also includes analyses of aconine and of pyraconitine hydrobromide.

Freund.			Dunstan and Carr.	
		Calculated.	Found.	Calculated.
		$C_{40}H_{53}NO_{14}$.		$C_{39}H_{51}NO_{15}$.
Triacetyl aconitine,	C	62·25	60·42	60·54
	H	6·87	6·82	6·59
		$C_{38}H_{51}NO_{13}$.		$C_{37}H_{49}NO_{14}$.
Diacetyl aconitine,	C	62·55	60·98	60·74
	H	6·99	7·06	6·70
		$C_{32}H_{43}NO_9HBr$.		$C_{31}H_{41}NO_{10}$.
Pyraconitine hydro-bromide,	C	57·65	55·8	55·69
	H	6·60	6·28	6·28
		$C_{25}H_{41}NO_9$.		$C_{24}H_{39}NO_{10}$.
Aconine,	C	60·12	57·31	57·48
	H	8·21	8·02	7·78

In establishing their new formula for benzaconine ($C_{31}H_{43}NO_{11}$) the authors relied on the determination showing that one molecular proportion of acetic acid is separated when it is formed from aconitine ($C_{33}H_{45}NO_{12}$). The base being amorphous did not lend itself well to the confirmation of this formula, especially as the composition of the alkaloïd only differs within the limits of experimental error from that of aconitine. They showed, however, that the percentage of gold in the remarkable colourless aurichlorbenzaconine agrees well with the calculated number. Freund and Beck state that they have been unable to obtain this substance. The authors can only reply that they find no difficulty whatever in producing it, and that one of them, in conjunction with Mr. E. F. Harrison, has now succeeded in converting it into a crystalline aurichloride.

19. "Aconitine aurichlorides." By Wyndham R. Dunstan, F.R.S., and H. A. D. Jowett, B.Sc.

In a previous communication (Trans., 1893) the authors described three modifications of aconitine aurichloride, differing in melting point and apparently in crystalline form, each being produced under different conditions from the amorphous aurichloride and convertible into each other. The α-compound (m. p. 135°) was obtained by crystallising from aqueous alcohol, aqueous acetone, or from a mixture of chloroform and ether; the β-compound (m. p. 152°) was formed by crystallising from strong alcohol, and the γ-compound (m. p. 176°) by crystallising the β-compound from a mixture of chloroform and ether.

Freund and Beck (*Ber.*, **27**, 724) have stated that the α-aurichloride is really a trihydrate, and that the β-compound is the anhydrous salt; the γ-compound they do not mention. They describe a new salt which they state is an alcoholate, and is obtained by crystallising from absolute alcohol; this salt melts at 135° and loses its alcohol when heated or left for a long time in the desiccator.

The authors have, therefore, again examined the aurichlorides, and have confirmed their previous results. The α-aurichloride cannot be regarded as a trihydrate since it contains 19·64 per cent. of gold, the formula $C_{33}H_{45}NO_{12},HAuCl_4$ requiring 19·89 per cent., or, using Freund's formula for aconitine, 19·93 per cent., whereas a trihydrate requires either 18·86 per cent. or 18·89 per cent., depending on which formula is taken. On heating at 100—120° during many hours and weighing at intervals, the total loss was much less (2 per cent.) than that required for the trihydrate, although the salt had slightly decomposed. After this prolonged heating, the substance still melted very close to its original point.

Moreover, they have now succeeded in producing the α-aurichloride in the absence of water by crystallising from anhydrous acetone.

The authors have also examined the substance which Freund and Beck regard as an alcoholate of aconitine aurichloride. The salt prepared by the method they describe closely resembled the β-aurichloride in appearance. The air-dried salt melted indefinitely between 145—152°, but (after drying at 100°) at 152°. By drying this substance under different conditions the authors find that the loss is variable, but in no case does it amount to the percentage required for an alcoholate—4·46 or 4·47 per cent. They conclude that this substance is merely the β-aurichloride with a small quantity of alcohol still adhering to it; this alcohol is slowly lost when the salt is exposed to air.

ANNIVERSARY DINNER.

It has been arranged that the Fellows of the Society and their friends shall dine together at the Hotel Métropole on Wednesday, March 27th, at 6.30 for 7 P.M. It is hoped that as many Fellows as possible will be present.

ERRATUM in "Proceedings," No. 146, page 4, line 7, *for* $C_{12}H_{20}O_9(N_2HC_6H_5)_2$ *read* $C_{18}H_{30}O_{14}(N_2HC_6H_5)_2$.

At the next meeting on Thursday, February 21st, *there will be a ballot for the election of Fellows*, and the following papers will be read:—

"The electromotive force of an iodine cell." By A. P. Laurie.

"Contributions to the chemistry of cellulose." By Messrs. Cross, Bevan, and Beadle.

"The melting points of mixtures." By H. Crompton and Miss M. A. Whiteley.

"The volumetric determination of manganese." By Messrs. J. Reddrop and H. Ramage.

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PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

EDITED BY THE SECRETARIES.

No. 148. Session 1894–95.

February 21st, 1895. Dr. Armstrong, President, in the Chair.

Mr. Alexander Cameron was formally admitted a Fellow of the Society.

Certificates were read for the first time in favour of Messrs. Herbert William Cook, B.Sc., West Mount, Upton, Macclesfield; Edric Druce, Worleston, Nantwich; H. Loft Haller, 27 Hilda Street, Beverley Road, Hull; George Elliott Shaw, 9 Basing Road, Westbourne Park, W.

It was announced that the following changes in the Officers and Council were proposed by the Council.

As *President:* A. G. Vernon Harcourt, M.A., D.C.L., LL.D., F.R.S., *vice* Professor H. E. Armstrong, LL.D., Ph.D., F.R.S.

As *Vice-Presidents:* Professor Roberts Austen, F.R.S., and Professor Japp, F.R.S., *vice* A. Vernon Harcourt, F.R.S., and Professor William Ramsay, F.R.S.

As *Ordinary Members of the Council:* Professor Bedson, Mr. B. Brough, Mr. Hehner, and Professor McLeod, F.R.S., *vice* Charles F. Cross, A. G. Green, W. H. Perkin, jun., F.R.S., and John A. Voelcker, Ph.D.

Messrs. Evan Bevan, Bertram Blount, and E. W. Voelcker were appointed to audit the Society's accounts.

The following were duly elected Fellows of the Society:—Herbert Anderson, John Melrose Arnot, David Butler Butler, Francis H. Carr, Thomas Bennett Case, B.A., Tom Crossman, Frederic Weldon Daw, Edward Elliott, Henry Fairrie, Alexander Macfarlane, Herbert

Edward Gardner, Henry Tresawna Gerrans, M.A., George Goldfinch, Donald St. John Grant, M.A., M.B., Herbert Grime, Weldon Hanson, Harry Harris, Walter Harris, B.A., Ph.D., Hugh Hastings, John Adams Hatfield, Edward Herbert Hill, Percy Hudson, Edgar Joseph, Richard Ernest Kenyon, B.Sc., George Holman Kingdon, B.A., Patrick Henry Kirkaldy, Arthur Marshall, William Baxter McVey, Robert Meldrum, Harry Edward Niblett, B.A., James Albert Offord, Harry James Powell, Herbert Lewin Robinson, Thomas Chilwell Sharrott, Herbert Frederick Stephenson, Henry R. Le Sueur, B.Sc., Thomas C. Warrington, B.A., David John Williams, Evan Williams, Harry Wilson, Henry Stow Young.

Of the following papers those marked * were read.

*20. "The electromotive force of an iodine cell." By A. P. Laurie, M.A.

A cell consisting of a zinc and platinum plate, immersed in a solution of iodine in potassium iodide, gives a definite and constant E.M.F., the zinc being dissolved at the expense of the iodine surrounding the platinum plate. On diminishing the strength of the iodine solution the E.M.F. gradually falls off, the rate increasing as the iodine becomes very dilute; the E.M.F. for a 0·1 per cent. solution being 1·460 volts, and for a 0·001 per cent. solution 1·369 volts. If potassium iodide free from iodine is used, an E M.F. of about 1·172 volts is obtained. This value is uncertain, and varies for different platinum wires and at different times for the same platinum wire, the highest value being obtained with a wire boiled in soda, then in nitric acid, then washed, and finally heated white hot. If this wire, however, is left in the solution it gradually falls in E.M.F. to about the value given above.

On adding a trace of iodine, 0·0001 per cent., the E.M.F. at once rises to about 1·320 volts, the reading differing slightly for different wires and on increasing the amount of iodine the E.M.F. goes on rising, the readings rapidly approximating until before 0·001 per cent. is reached the readings are all the same.

Above this value the E.M.F. rises more slowly, but with regular movements, consequently the E.M.F. becomes a measure of the strength of the solution. The author proposes to use these results for measuring the rate of diffusion of very dilute solutions of iodine, and has made more preliminary experiments with the view of doing this.

On diffusing a solution of 0·01 per cent. iodine from a short glass tube, with a platinum wire inserted in the closed end, into a mixture of potassium iodide, and taking readings of E.M.F. every half hour, a very regular curve was obtained showing the gradual diminution of the strength of the iodine solution, and in substituting cadmium for potassium iodide as the solvent, results were obtained so nearly agreeing that apparently the iodine is diffusing independently of the potassium iodide or cadmium iodide molecules. The author is now engaged in trying to measure the actual rate of diffusion, and the relation between the rate of diffusion and the temperature of the solution. Incidentally the results show that determinations of the E.M.F. between metals and solutions require in certain cases to be made with considerable care, if the results are to be of any value.

*21. "Contributions to the chemistry of cellulose." By C. F. Cross, B.Sc., E. J. Bevan, and C. Beadle.

In a recent monograph ("Cellulose": Longmans, 1895) the authors have suggested a classification of the experimental facts on this subject, and at the same time have pointed out directions for future research. The present paper is a report of progress of investigation upon these lines. The first part is devoted to generally tracing the analogies of cellulose, as a chemical unit, with the salts, and incidentally the points of sharp distinction between cellulose and starch; the experimental study of these points leads to the conclusion that it is not a polyaldose (or aldosan) of the starch type. The points emphasised are: (1) the resistance to hydrolysis as exemplified by the quantitative regeneration of cellulose from the cycle of reaction involved in the formation and decomposition of the xanthates; (2) "double salt" reactions of cellulose with zinc salts, and the interaction of the cellulose-zinc acetate with acetyl chloride in the cold (at about 30°) forming acetylated derivatives; (3) the mode of decomposition of these cellulose acetates point to the formula $C_6H_6O(OAc)_4$; (4) certain electrolytic phenomena of the cellulose hydrates which show that in presence of water cellulose is sensitive to the action of the electric current; the metal of a metallic conductor, taken as the "positive" or anode, is attacked and carried forward in the direction of the current and deposited in the cellulose in a condition of chemical union.

These points have been worked out in experimental detail, and establish several characteristic features which sharply distinguish it from other "colloidal carbohydrates." The electrolytic phenomena are, however, shown by very various substances, *e.g.*, silk, wool, asbestos, &c. In the later sections of the paper the authors, in collaboration with Claude Smith, give the results of experiments on the special group of "natural oxycelluloses," of which the celluloses of the *Graminiæ* are typical. These researches include (1) studies of germination in relation to the furfural-yielding constituents of the tissues of the seedlings; (2) the further history of the plant, for which special barley plots of the Woburn experimental station were selected. The authors have also investigated the furfural reaction, and determined the proportion of volatile acids (formic and acetic) which are formed as bye-products of the condensation. Progress has likewise been made in isolating the "furfuroids" of these celluloses. Treatment with sulphuric acid of 1·6 sp. gr. and dilution with water separates the fibrous cellulose into a normal cellulose (insoluble hydrate) and soluble carbohydrates giving a large yield of furfural (50 per cent.), but none of the characteristic reactions of the pentosans. It appears to be now generally admitted that these furfural-yielding constituents of plants are products of metabolism of hexoses and hexosans (Cross and Bevan, *Berl. Ber.*, **26**, 2520; **27**, 1061; De Chalmot, *ibid.*, **27**, 1489), though the question of their identity seems to be still a matter of controversy. The evidence, however, so far is against an indiscriminate classification of these bodies as pentoses and pentosans.

*22. "The melting points of mixtures." By Holland Crompton and Miss M. A. Whiteley.

The authors have determined the melting points of mixtures containing two organic compounds in various proportions. They come to the following conclusions from the results of these experiments.

1. In all normal cases of solutions in which on solidification the solvent first of all separates out in the pure state, the relationship $\log s = \frac{\rho}{1{\cdot}98}\,\frac{T-T'}{TT'}$ holds. Here s is the number of molecules of the solvent contained in one molecule of the solution, ρ is the molecular latent heat of fusion, and T the melting point in absolute temperature of the solvent, T′ the melting point of the mixture or solution.

2. For ρ, the value $1{\cdot}38\ \Sigma v\mathrm{T}$ can be substituted where Σv is a number derived from the valencies of the atoms comprising the molecule (Proc., 1894, 240).

3. In a number of instances the observed melting points of the mixtures are higher than those calculated by these formulæ, and in such cases the discrepancies may be accounted for by assuming that the pure solvent does not separate out from the solution on solidification, but that a solid solution is formed by union of a certain quantity of the dissolved substance with the solvent.

*23. "The volumetric determination of manganese." By Joseph Reddrop and Hugh Ramage.

The authors have examined a method proposed by L. Schneider (*Journ. Chem. Ind.*, 1888, p. 693), in which the manganese salt is oxidised by bismuth peroxide in presence of nitric acid to permanganic acid. After filtration through asbestos.the permanganic acid is determined by titration with hydrogen peroxide. The best strength of nitric acid is 250 c.c. (sp. gr. 1·2) per litre, but the permanganic acid decomposes in the acid solution, and to prevent this decomposition, it is filtered into an excess of hydrogen peroxide, and finally titrated with potassium permanganate. It is shown that the error in Schneider's method is at least 0·6 per cent. in the analysis of ferromanganese, and 0·06 per cent. in that of steel.

Sodium bismuthate prepared from materials free from chlorine, replaces the bismuth peroxide used by Schneider. It is prepared by fusing soda, basic bismuth nitrate, and sodium peroxide; on washing with water the insoluble compound remains.

The analysis of ferromanganese, spiegel, silico-spiegel, iron, and steel are described in detail, and the accuracy of the method established by experiments on quantities of manganese ranging from 0·1 per cent. to 80·7 per cent. In a sample of ferromanganese, they obtained by the ordinary gravimetric method using ammonium salts and correcting for impurities, 80·63 per cent.; by Pattinson's method, 80·70 per cent.; by the present method, 80·67 per cent. Chromium, copper, nickel, and cobalt up to 5 per cent., are shown to raise the results but very slightly. Sulphuric acid up to normal strength does not interfere, and may therefore be used to expel hydrochloric acid from solutions in which it has been used in dissolving the sample.

The oxidation, filtration, and titration may by this method be completed within 15 minutes.

24. "Bromocamphoric acid, an oxidation product of π-dibromocamphor." By F. Stanley Kipping, Ph.D., D.Sc.

It has recently been shown (Kipping and Pope, Proc., 143, 212) that an optically active π-dibromocamphor, melting at 152—153°, can be prepared by gently heating bromocamphorsulphonic bromide; the further investigation of this dibromo-camphor has already led to interesting results, which are briefly described in this note.

On boiling the π-dibromo-compound with concentrated nitric acid for some hours a part undergoes oxidation, and on cooling and adding water, a crystalline product is deposited, together with a pale yellow thick oil.

The crystalline product separates from alcohol in nodular aggregates, and melts at about 217° with decomposition; its melting point and its origin seemed to point to its identity with the bromocamphoric anhydride (m. p. 215—216°) described by Wreden, and more recently investigated by Rupe and Maull, Auwers and Schnell, and Aschan, but analysis and further examination showed that this was not so. The compound has the composition $C_{10}H_{15}BrO_4$ (found C = 43·2, H = 5·4; Calc. C = 43·0, H = 5·4 per cent.); it has an acid reaction to litmus, dissolves freely in cold sodium carbonate solution, and also differs from bromocamphoric anhydride in being only very sparingly soluble in chloroform. For these and other reasons it must be regarded as a *bromocamphoric acid*, structurally isomeric with the as yet unknown bromocamphoric acid from which Wreden's anhydride is derived.

When the acid is gently heated with acetic chloride it is converted into the anhydride $C_{10}H_{13}BrO_3$ (found C = 45·92, H = 5·16; Calc. C = 45·97, H = 4·97 per cent.); this compound crystallises very well, melts at 155—156°, and does not dissolve in cold sodium carbonate solution.

When the acid is warmed with aqueous potash for a few minutes and the solution cooled, no precipitate is produced on acidifying (although the original acid is very sparingly soluble in cold water); alcoholic potash also acts readily on the acid converting it into a very thick, colourless syrup, which could not be crystallised. This syrup has an acid reaction, is miscible with water, and dissolves in aqueous sodium carbonate with effervescence, giving a solution which does not reduce potassium permanganate; it seems to be a hydroxy-acid of the composition $C_{10}H_{16}O_5$ (Found C = 54·2, H = 7·4, Calc. C = 55·5, H = 7·4) but as it was not specially purified the analysis is not decisive.

The pale yellow oil which is obtained along with the bromocamphoric acid is a mixture; when it is warmed with alcoholic potash for some time and the alcohol evaporated crystals of the original π-dibromocamphor are deposited, and the alkaline solution yields when acidified a crystalline substance which contains nitrogen. This is a *nitrobromocamphor*, $C_{10}H_{14}(NO_2)BrO$ (Found C = 43·21, H = 5·07) but is not identical with the known compound; it separates from a mixture of chloroform and light petroleum in needles melting at 133—134°, and is soluble in aqueous potash and sodium carbonate, but is almost insoluble in water.

25. "Note on the action of diastase on cold starch-paste." By Horace T. Brown, F.R.S., and G. Harris Morris, Ph.D.

The authors draw attention to the generalisation which they claim to have established in previous communications, namely, that the products of a starch transformation, or any part of them separated by any method of fractionation, can always be expressed, in the terms of maltose, having an optical activity of $[\alpha]_{j3\cdot86} = 150°$, and a cupric-reducing power of $\kappa_{3\cdot86} = 61$, and of dextrin, having an optical activity of $[\alpha]_{j3\cdot86} = 216°$ and no reducing power; in other words, knowing the cupric-reducing power of any starch product, the optical activity can be predicted with accuracy, and *vice versâ*. This fact is quite independent of any consideration of the true nature of the intermediate products between starch and maltose, and has been ignored by certain recent workers.

In a paper by Brown and Heron (Trans., 1879, p. 627) it is mentioned that during the early stages of the action of diastase upon starch-paste in the cold, there is an apparent exception to this rule, the optical activity being *lower* than it should be on the assumption that only maltose and dextrin are present. After standing some hours, or on boiling, this discrepancy disappears, and the optical cupric-reducing powers show the same relationship that they do in conversions made at higher temperatures. An observation made by O'Sullivan and Tompson in another direction suggested an explanation of these abnormal results, and in the present paper the authors show that the lower angle of rotation observed during the earlier stages is due to the maltose being liberated in the state of "half rotation," a condition which freshly-prepared solutions of pure maltose always show. When freshly dissolved the optical power of maltose bears the relation to that of a boiled or old solution of about 133° to 150°, and the authors show that this relationship holds good in the case of freshly-prepared products from cold starch-paste.

26. "On the magnetic rotation of some unsaturated hydrocarbons." By W. H. Perkin, Ph.D., F.R.S.

In this paper it is shown that the magnetic rotations of the olefines do not differ from those of the paraffins to quite such a large extent as do other substances correspondingly unsaturated, the vinyl compounds excepted. In the case of diallyl, which is twice as unsaturated, the increase in the magnetic rotation is, however, proportionally a little larger, being more than twice that of the olefines. A comparison is made of the boiling points, densities, and specific rotations of the six-carbon hydrocarbons, hexane, hexylene, diallyl, and dipropargyl, and it is shown that the differences between dipropargyl and diallyl are not of the same order as of those between hexane and hexylene, being of an opposite kind in the boiling points and much larger in the other properties. The molecular rotations, however, which involve both density and specific rotation, exhibit greater regularity, the two acetylene linkages influencing the molecular rotation to the same extent as four ethylene linkages. The molecular rotation of isoprene does not differ much from that of diallyl, if the difference of CH_2 in its composition is allowed for.

ANNIVERSARY DINNER.

Hotel Métropole, Wednesday, March 27th, at 7 p.m.

In order to facilitate the arrangements for the Dinner, it is particularly requested that all Fellows who intend to be present will at once notify their intention to the Secretaries at Burlington House.

At the next meeting on Thursday, March 7th, the following paper will be read :—

"On dimethylketohexamethylene." By Dr. Kipping.

LIST OF FELLOWS.

A new List of Officers and Fellows of the Chemical Society being in course of preparation, it is requested that Fellows will send any alteration of Name or Address, without delay, to the Assistant Secretary, Burlington House, London, W.

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PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

EDITED BY THE SECRETARIES.

No. 149. Session 1894–95.

March 7th, 1895. Dr. Armstrong, President, in the Chair.

Messrs. H. F. Stephenson, E. Joseph, H. L. Robinson, D. B. Butler, F. C. Sharrott, and J. A. Hatfield were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Prosper Henry Marsden, 47, Alma Road, Birkdale; Robert Selby Morrell, M.A., Ph.D., Gonville and Caius, Cambridge; Frederick Gwilym Trehaine, Llyndirw, Llanishen, near Cardiff; Arthur William Warwick, Minah Mine, Wickes, Montana, U.S.A.

Notice was given of the following alterations in the bye-laws proposed by the Council :—

In Bye-law I, at line 7, after the words "personally known" to strike out the remainder of the paragraph and substitute the following :

"And the name of such Candidate shall be read at three ordinary scientific meetings, and such Certificate shall be published in full in the Society's Proceedings, and suspended in the Society's Rooms or place of meeting, until the Candidate has been duly balloted for."

In Bye-law V, lines 2—4, to substitute the words "be two annual subscriptions in arrears," for the words "have left his subscriptions unpaid for two years, reckoning from the 1st of January preceding."

Of the following papers those marked * were read.

*27. "Dimethylketohexamethylene." By F. Stanley Kipping, Ph.D., D.Sc.

The oil obtained on distilling the calcium salt of $\alpha\alpha'$-$\alpha\alpha'$-dimethylpimelic acid with soda-lime (*Proc.*, 1892—93, 121—68) has been further investigated; the dimethylketohexamethylene which it contains has been isolated in a state of purity by acting on the fractionated product with hydroxylamine, separating the crystalline oxime thus produced, and decomposing it with hydrochloric acid.

Dimethylketohexamethylene is a colourless, mobile liquid boiling at 174—176°; it readily volatilizes with steam and has a very strong peppermint-like odour.

The oxime, $C_8H_{15}NO$ (Found $C = 68{\cdot}03$, $H = 10{\cdot}76$; Calc. $C = 68{\cdot}08$, $H = 10{\cdot}64$ per cent.) crystallises from dilute alcohol in long needles melting at 114—115°; it has a strong smell very similar to that of camphoroxime.

When dimethylketohexamethylene is treated with warm, moderately concentrated nitric acid, it is rapidly attacked, but the first product of oxidation was not obtained in a crystalline condition; on prolonged boiling with nitric acid the ketone is converted into a crystalline substance, melting at 65—68°, the properties of which, as far as could be ascertained, are identical with those of the lactone of α-hydroxy-α-methylglutaric acid.

*28. "The use of barium thiosulphate in standardising iodine solution."

By R. T. Plimpton, Ph.D., and J. C. Chorley.

The authors find that barium thiosulphate, $BaS_2O_3H_2O$, prepared by precipitation from solutions of sodium thiosulphate and barium chloride, is well adapted to the titration of iodine solutions. The substance can easily be obtained pure, keeps well, and reacts readily with a solution of iodine, while the progress of the reaction is marked by the gradual disappearance of the crystals which are oxidized to soluble barium tetrathionate. An important advantage in the use of barium thiosulphate is its high molecular weight, 267 parts of the substance corresponding to 127 parts of iodine. 50 grams sodium thiosulphate and 40 grams barium chloride are dissolved each in 300 c.c. of water, the warm solutions mixed and the crystalline powder which soon separates collected, thoroughly washed with cold water, and dried at 30° C. The precipitate has the composition $BaS_2O_3H_2O$, and would lose water if dried at a much higher temperature.

In performing the titration a weighed quantity of the powder is placed in a stoppered bottle and shaken with water; the iodine is run in until the thiosulphate is almost dissolved, starch solution is then added and the process completed, care being taken to thoroughly shake the bottle after each addition of iodine.

29. "The melting points of racemic modifications and of optically active isomerides." By F. Stanley Kipping, Ph.D., D.Sc., and William J. Pope.

The melting point of a racemic compound is, in almost all cases, different from that of its optically active isomerides; only a few substances are known of which the racemic and optically active isomerides have the same melting point, and even in these cases it is by no means certain that the supposed racemic modification is not merely a mixture in equal proportions of the two isomerides of opposite optical sign.

During the investigation of π-monobromocamphor, we found the optically inactive form of this substance to be a true racemic compound, since it crystallises in an optically biaxial system, whilst its dextro-isomeride crystallises in the uniaxial tetragonal system; both racemic and active forms have the same melting point, the two substances melting sharply at 93—94°. A series of determinations of the melting points of various mixtures of these isomerides was made in order to ascertain the influence exerted on the point of fusion of the one by the other; this led to the somewhat remarkable result that, in spite of the difference in crystalline form, mixtures of the two substances, as well as the pure compounds themselves, melt at the same temperature, viz., 93—94°.

On examining the corresponding chloro-derivatives, we found that dextro-π-monochlorocamphor also melts at the same temperature as its inactive isomeride; further, the melting point of mixtures of the two substances is always the same as that of the pure constituents. We cannot assert that the inactive modification of π-monochlorocamphor is a true racemic modification with the same certainty as in the case of the bromo-compound, the crystals of the former being very poorly developed and not suitable for crystallographic measurement.

The racemic nature of inactive π-monobromocamphor is, however, beyond all question, and we therefore conclude that it is possible for a true racemic compound not only to melt at the same temperature as its optically active isomeride, but also to have no effect on the melting point of the latter when mixed with it. This behaviour is analogous to that of mixtures of two isomorphous substances for which the curve plotted between the molecular compositions and the melting points is a straight line joining the melting points of the two pure substances.

30. "Phenyl ethers of methylene- and ethylene-glycols. Synthesis of α-methylbutyrolactone." By E. Haworth, B.Sc., and W. H. Perkin, jun., F.R.S.

These substances, which are required in the course of some synthetical experiments now in progress, were prepared as follows.

Methyleneglycol diphenylether, $C_6H_5\cdot O\cdot CH_2\cdot O\cdot C_6H_5$, is obtained when methylene chloride is digested in alcoholic solution with sodium phenate; it is a colourless, crystalline substance which melts at 20°, and distils at 205° (50 mm.).

Ethyleneglycol phenylether, $C_6H_5\cdot O\cdot CH_2\cdot CH_2\cdot OH$, is formed quantitatively when glycolchlorhydrin reacts with sodium phenate; it is a thick, colourless liquid which boils at 165° (80 mm.).

When ethylene bromide is digested with sodium phenate, *bromhydrin phenylether*, $C_6H_5\cdot O\cdot CH_2\cdot CH_2Br$, a colourless, crystalline mass, m. p. 32°, b. p. 144° (40 mm.), is obtained with glycoldiphenylether, $C_6H_5\cdot O\cdot CH_2\cdot CH_2\cdot O\cdot C_6H_5$, colourless crystals, m. p. 96°.

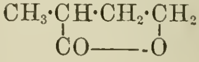
Chlorhydrin phenylether, $C_6H_5\cdot O\cdot CH_2\cdot CH_2Cl$, is obtained when ethylenechlorobromide, $Br\cdot CH_2\cdot CH_2Cl\cdot$, is digested with sodium phenate; it is a colourless, crystalline solid which melts at 30°, and distils at 220°.

The preparation of α-methylbutyrolactone was conducted as follows.

The sodium compound of ethylic methylmalonate was digested in alcoholic solution with bromhydrin phenylether, and the resulting *ethylic γ-phenoxyethyl-α-methylmalonate*,

$$(COOC_2H_5)_2\cdot C(CH_3)\cdot CH_2\cdot CH_2\cdot O\cdot C_6H_5,$$

a colourless liquid, b. p. 230° (45 mm.), converted by hydrolysis into *γ-phenoxyethy-α-methylmalonic acid*, $(COOH)_2\cdot C(CH_3)\cdot CH_2\cdot CH_2\cdot O\cdot C_6H_5$. This crystalline acid, which melts at 125°, is decomposed on distillation into carbon dioxide and γ-phenoxyethyl-α-methylacetic acid (m. p. 77°); and this, by treatment with hydrobromic acid and subsequent digestion of the product with sodium carbonate solution, yields phenol and *α-methylbutyrolactone*,



$\begin{array}{l} CH_3\cdot CH\cdot CH_2\cdot CH_2 \\ \quad\ \ | \qquad\qquad\quad\ | \\ \quad CO\text{------}O \end{array}$

, which is a colourless oil distilling at 201°.

31. "Methyl isobutyl acetic acid, $(CH_3)_2CH\cdot CH_2\cdot CH(CH_3)\cdot COOH$." By W. H. Bentley, B.Sc., and M. W. Burrows, B.Sc.

This acid, which has not hitherto been described, was required for the purpose of comparing its properties with those of some fatty acids obtained by fusing camphoric acid with potash. The present paper deals with its preparation and properties.

Isobutyl bromide, $(CH_3)_2\cdot CH\cdot CH_2Br$, was heated with the sodium derivative of ethylic methyl malonate, the product being ethylic methylisobutyl malonate, $(CH_3)_2\cdot CH\cdot CH_2\cdot C(CH_3(COOC_2H_5)_2$, distilling at 230—235°. This, on hydrolysis, yielded the corresponding dibasic acid—methylisobutylmalonic acid, $(CH_3)_2\cdot CH\cdot CH_2\cdot C(CH_3)(COOH)_2$, which melts at 122°, and on distillation is decomposed, forming methylisobutylacetic acid, $(CH_3)_2CH\cdot CH_2\cdot CH(CH_3)\cdot COOH$. The pure acid boils at 204—205°, and in its properties resembles the other higher acids of the fatty series.

The following derivatives have been prepared in order to assist in its identification.

Ethyl Salt, $C_6H_{13}\cdot COOC_2H_5$.—A colourless oil boiling at 165—166°.

Anilide, $C_6H_{13}\cdot CO\cdot NH\cdot C_6H_5$.—A colourless solid crystallising from petroleum in silky needles; m. p. 110°.

p-*Toluide*, $C_6H_{13}\cdot CO\cdot NH\cdot C_7H_7$.—A colourless solid melting at 86°.

ADDITIONS TO THE LIBRARY.

I. *Donations.*

Report on the Improvement of Indian Agriculture. By John Augustus Voelcker, Ph.D., B.A., &c., Consulting Chemist to Royal Agricultural Society of England. Pp. 33 + 460. 3 Maps. London 1893. From the Author.

Roscoe-Schorlemmer's Kurzes Lehrbuch der Chemie nach den neuesten Ansichten der Wissenschaft. Von Sir Henry E. Roscoe, LL.D., F.R.S., und Alexander Classen. Mit 71 Holzstichen und einer farbigen Spectraltafel. Zehnte vermehrte Auflage. Pp. xxvi + 541. Braunschweig 1894. From Sir H. Roscoe.

Roscoe-Schorlemmer's Lehrbuch der Anorganischen Chemie. Von Sir Henry E. Roscoe, LL.D., F.R.S., und Alexander Classen. Erster Band. Dritte gänzlich umgearbeitete und vermehrte Auflage. Mit eingedruckten Holzstichen. Erste Abtheilung. Pp. 528 Braunschweig 1895. From Sir H. Roscoe.

Elementary Qualitative Chemical Analysis adapted for use in the Laboratories of Colleges and Schools. By Frank Clowes, D.Sc., Lond., and J. Bernard Coleman. Pp. xii + 180. London 1894. From the Publisher.

Ceylon Manual of Chemical Analyses. A Handbook of analyses connected with the Industries and Public Health of Ceylon. For planters, commercial men, agricultural students, and members of Local Boards. By M. Cochran, M.A., F.C.S. Pp. 4 + 310 + xiv. Colombo 1895. From the Author.

At the next meeting on Thursday, March 21st, the following papers will be read:—

"Studies in isomeric change. Part. III. The ethylbenzenesulphonic acids." By Dr. G. T. Moody.

"Some oxypyridine derivatives." By Miss Sedgwick and Dr. Collie.

"On the colouring principle of *Ioddalia aculeata* and *Evodia meliæfolia*." By A. G. Perkin and J. J. Hummel.

ANNIVERSARY MEETING.

This meeting, at which the election of Officers and Council for the ensuing year will take place, will be held on Wednesday, March 27th, at 3 o'clock in the afternoon.

ANNIVERSARY DINNER.

Hotel Métropole, Wednesday March 27th, at 7 p.m.

The President, Professor Armstrong, F.R.S., in the Chair.

The final arrangements for the Anniversary Dinner being nearly completed, and a number of distinguished guests having accepted invitations, the Dinner Committee particularly request that all Fellows who intend to be present will at once send in their names to the Secretaries, if they have not already done so.

LIST OF FELLOWS.

A new List of Officers and Fellows of the Chemical Society being in course of preparation, it is requested that Fellows will send any alteration of Name or Address, without delay, to the Assistant Secretary, Burlington House, London, W.

HARRISON AND SONS, PRINTERS IN ORDINARY TO HER MAJESTY, ST. MARTIN'S LANE.

Issued 13/4/1895.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

EDITED BY THE SECRETARIES.

No. 150. Session 1894–95.

March 21st, 1895. Dr. Armstrong, President, in the Chair.

Messrs. George Thudichum and Arthur H. Coote were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Harold Allden Auden, B.Sc., 102 Acomb Street, Manchester; Lancelot Alexander Borradaile, B.A., Selwyn Coll., Cambridge; Henry Bradford, 21 Kensington Mansions, Earl's Court, S.W.; Irving Foster Hasslewood, The Elms, Aulaby Road, Hull; Robert Charles Marchant, 18 Westfield Park, Redland, Bristol; Henry F. A. Wigley, B.A., 64 Quentin Road, Lee, S.E.

Of the following papers those marked * were read.

*32. "The volumetric determination of sugars by an ammoniacal cupric solution." By Zdeněk Peške. (Communicated by Professor Brauner.)

Being dissatisfied with Fehling's method and its rather lengthy modification by Allen, and with the gravimetric method of Soxhlet-Allihn, the author tried to find a rapid and reliable process of estimating sugar based on Pavy's method of working in an ammoniacal solution. The latter method fails on account of the rapidity with which the reduced ammoniacal cupric solution is oxidised by the air. The author avoids this by covering the solution with a layer of paraffin oil of high boiling point ("white vaseline oil"). It is necessary to keep the amount of ammonia constant. The use of a current of indifferent gas was proposed to the author and tried by him some one and a half years ago, but was given up as the liquid rapidly loses ammonia, and its reducing factor is thereby so altered that constant results cannot be obtained. Tables are given showing the reducing power of a standard ammoniacal cupric solution (in presence of Rochelle salt) for liquids containing different amounts of (1) glucose, (2) invert sugar, (3) invert sugar in presence of cane sugar.

*33. "The action of hydrogen sulphide on antimonic acid solutions." By Otto Bošek, Ph.D. (Communicated by Prof. Brauner.)

Berzelius, Rose, Rammelsberg, Bunsen, Willm, Thiele, and others having obtained contradictory results, the question has been reinvestigated.

The complete conversion of antimonious into antimonic compounds by the action of oxidising agents is difficult. Such agents as fuming nitric acid, potassium chlorate and hydrochloric acid, and even bromine in alkaline solution do not produce complete oxidation unless they act for a long time and are used in very large excess.

The experiments show the independent existence of compounds of the type SbX_4 (corresponding to the "antimonious acid" of Berzelius)· The author has succeeded in obtaining a crystalline double salt of the tetrachloride $3KCl \cdot 2SbCl_4$, and also the pure tetrasulphide Sb_2S_4, differing from either the trisulphide or the pentasulphide in its crystalline form and its highly characteristic pink colour.

An excess of an aqueous solution of hydrogen sulphide acting on antimonic acid solution at ordinary temperatures forms antimony pentasulphide, thus showing that exact results are obtained when Bunsen's directions are strictly followed.

When hydrogen sulphide acts on antimonic acid solutions, the quantity of antimony pentasulphide increases (*a*) the lower the temperature, (*b*) the more rapid the stream of hydrogen sulphide: while the quantity of antimony trisulphide mixed with sulphur increases (*a*) the higher the temperature, (*b*) the slower the action of the hydrogen sulphide. The quantity of the pentasulphide formed increases up to a certain limit (10 to 20 per cent.) with the amount of hydrochloric acid present, after which it diminishes. Antimonic solutions are more easily and completely reduced by hydrogen sulphide in presence of a chromic salt.

*34. "Action of hydrogen sulphide on antimonic, arsenic, and telluric acids." By B. Brauner, Ph.D.

When antimonic acid and hydrogen sulphide interact, one or both of the changes represented by the following equations may take place (1) $H_3SbO_4 + 5H_2S = Sb_2S_5 + 8H_2O$, (2) $2H_3SbO_4 + 5H_2S = Sb_2S_3 + S_2 + 8H_2O$. At first a solution is formed which apparently contains a colloidal modification of the pentasulphide, possibly H_3SbS_4. When antimonic acid is heated with hydrogen sulphide in a solution containing much free hydrochloric or sulphuric acid, antimony pentasulphide is precipitated. Neither oxysulphantimonic acid nor any oxysulphantimonate corresponding with the analogous arsenic compounds could be obtained.

The more positive behaviour of antimony, as compared with arsenic, is in accordance with the relative positions of these elements in the periodic table.

In its behaviour towards hydrogen sulphide, telluric acid resembles arsenic acid more than antimonic acid, but no oxysulphotelluric acid could be isolated. It is known that antimony pentasulphide is decomposed into the trisulphide and sulphur when heated to 220°. The author finds that the same change occurs when the pentasulphide is exposed to sunlight and when it is heated with water to 98°, the trisulphide separating in the black crystalline form.

*35. "The atomic weight of tellurium." By Bohuslav Brauner, Ph.D.

In continuation of his work on the determination of the atomic weight of tellurium, published in the Transactions, 1889, p. 382, the author has recalculated the numerical data then obtained, and on reducing to a vacuum finds the number 127·71, which is higher by 0·86 than the atomic weight of iodine 126·85, whereas from its position in the periodic system tellurium should have an atomic weight between 123 and 125. On this account, he is led to the conclusion that tellurium is not a simple substance, a conclusion which is supported by the following considerations. (1) Tellurium precipitated and dried in a current of an inert gas gives higher values for the atomic weight than when sublimed in hydrogen. (2) The properties and composition of the dibromide. (3) The varying results obtained on attempting the synthesis of the dioxide, the basic sulphate and certain metallic tellurides. (4) The behaviour of tellurous and telluric acid solutions towards hydrogen sulphide.

A large quantity of tellurium was therefore carefully purified by the process described in the paper referred to above, and, after being converted into sodium sulphotellurate, was submitted to a process of fractional precipitation similar to that used for separating the rare earths from one another. On examining these fractions, it was found that there were variations in the equivalent of the tellurium dioxide as determined by the permangate method described in the Transactions, 1891, p. 238. This variation, however, was found to be caused by the presence of minute quantities of mercury, thallium, bismuth, copper, and lead in the extreme positive fractions, and of arsenic and antimony in the negative fractions. On the other hand, the tellurium obtained by further purifying the middle fractions showed scarcely any variation in molecular weight.

In the course of experiments on telluric acid, made with the object of controlling the determination of the atomic weight of tellurium, the author has found that it is very difficult to prepare the acid in a pure state; moreover, it behaves like a mixture of two substances. He has also discovered a new modification of telluric acid corresponding with the yellow tellurates, the existence of which was predicted by Berzelius.

The discovery of argon inclines the author to believe that it is one of a new group of elements (or a mixture of them) in the periodic system—the Argon Group—coming between the last two groups, and if it be assumed that tellurium is a mixture, or alloy, or compound of the true tellurium with Argon No. 4, or "Triargon," it would consist of equal parts (atoms) of the two, $\frac{125\cdot4 + 130}{2} = 127\cdot7$, and have the formula $Te_2A^4_2$.

*26. "The hydrolysis of maltose by yeast." By G. Harris Morris, Ph.D.

Until E. Fischer recently described (*Ber.*, 1894, 2985, 3479) experiments on the hydrolysing action of yeast on maltose, the opinion had been generally held that maltose is directly fermented by yeast, or that if hydrolysis take place, this phenomenon and that of fermentation occurred simultaneously, as it had never been possible to detect products of hydrolysis in a solution of maltose undergoing fermentation. Fischer has, however, shown that air-dried yeast and its extract, when digested with a solution of maltose, readily converts a very considerable proportion into dextrose, and also that the extract of moist yeast cells which had been ruptured by trituration with powdered glass possessed the same power. Moreover, in the second paper, he states that when unruptured yeast-cells are digested with maltose solution for three days in presence of chloroform, some 40 per cent. of that sugar is converted into dextrose. Fischer chiefly used pure cultures of Frohberg yeast in his experiments, but he also examined low-fermentation yeast, and pure cultures of other races, with similar results.

Having in view the important nature of the subject, and the bearing it has upon the determination of cane sugar in the presence of maltose by inversion with yeast, the author has repeated Fischer's experiments. He has obtained results confirming Fischer's statements as to the action of air-dried yeast and its extract, and also of ruptured moist yeast, but was quite unable to obtain any evidence of hydrolysis when moist and well-drained yeast was employed, although both pure cultures of Frohberg yeast and ordinary London brewery yeast were used. The experiments were made by digesting a 5 per cent. solution of maltose with yeast (drained on a porous tile) in the proportion of 1 gram of yeast to 100 c.c. of solution. The digestions were carried on for periods varying from 24 hours to three days at 35° C. in the presence of chloroform. The solutions were examined before and after the digestion, and dextrose was also tested for after digestion with phenylhydrazine acetate in the usual way. In all cases the optical and cupric reducing powers remained unaltered after digestion, and no trace of dextrose could be detected by the phenylhydrazine test. In order to further examine the question, maltose solutions were set to ferment, portions of the fermented liquid being withdrawn from time to time, and the matter remaining unfermented examined by the above tests. In no case was the slightest evidence obtained of the presence of dextrose, the analytical results showing the presence of maltose, and maltose only, in the fermenting solution.

In order to obtain some explanation of this remarkable difference in the behaviour of well-drained but moist yeast, and of air-dried yeast, a quantity of the former was digested with chloroform water for 20 hours, in order to kill the cells, and then air-dried; any decomposition during drying, due to vital changes, was thus prevented. The dried yeast thus obtained possessed the same power as that dried in the ordinary way, and the author stated that Mr. F. W. Tompson had informed him that the yeast liquor, obtained as described in the paper of O'Sullivan and Tompson on invertase, which is manifestly a product of the decomposition of the yeast, and which possesses the power of inverting cane sugar to a most marked extent, was without action on maltose. That the action of dry yeast is not due to the cells being ruptured during powdering was shown by the fact that the horny mass remaining when yeast is dried on a porous tile was just as active when used in that form as when finely powdered before addition to the maltose solution.

The dry yeast has also the power of liquefying starch paste, and of producing dextrose from a starch-conversion from which all the soluble portions has been removed by repeated treatment with 80 per cent. alcohol.

The author is making further experiments to ascertain the cause of the hydrolysing action of dry yeast.

*37. "Studies in isomeric change. Part IV. Ethylbenzenesulphonic acids." By Gerald T. Moody, D.Sc.

In previous communications (Proceedings, 1888, 77; 1892, 90, 213 and 214) the author has called attention to the ease with which certain orthosulphonic acids of benzene derivatives undergo isomeric change, and are thereby converted into parasulphonic acids. The investigation has now been extended to the ethylbenzenesulphonic acids. The ethylbenzene available for these experiments was obtained from Kahlbaum, and was evidently impure, as, when shaken with sulphuric acid, it gave a bright red coloration, not due to free iodine.

As it has been stated by Chrustschow (*Ber.*, **7**, 1166) that ethylbenzene on sulphonation gives rise to two distinct acids, it was considered desirable to sulphonate a highly purified specimen of the hydrocarbon. To obtain such, the crude product of sulphonation of Kahlbaum's ethylbenzene was converted into barium salt, which was several times recrystallised and then converted into sodium salt. The latter was repeatedly recrystallised until no doubt as to its purity could exist, and then hydrolysed. The hydrocarbon thus obtained, which boiled at 135°, was sulphonated both with chlorosulphonic acid and with sulphuric acid. With each of these sulphonating agents one, and only one, sulphonic acid, namely, ethylbenzeneparasulphonic acid, was obtained. This behaviour of ethylbenzene is remarkable when compared with that of methylbenzene, which is known to give rise to a large proportion of ortho-acid on sulphonation. Ethylbenzeneparasulphonic acid forms a well characterised barium salt which is anhydrous and does not contain 1 mol. of water of crystallisation, as stated by Sempotowski (*Ber.*, **22**, 2662), and a sodium salt which crystallises with $\frac{1}{2}$ a molecular proportion of water. The sulphonic chloride solidifies in a freezing mixture and melts at 12°; the sulphonamide crystallises from water in needles, from alcohol in six-sided plates, and melts at 110°.

In order to obtain ethylbenzeneorthosulphonic acid, ethylbenzene was brominated and the resulting bromoethylbenzene sulphonated and converted into barium salt. The less soluble barium salt which crystallises in characteristic, long, shining plates, is a derivative of parabromethylbenzeneorthosulphonic acid. It contains 3 mols. of water of crystallisation, and yields a beautiful sodium salt. The latter, on reduction with zinc dust and sodium hydroxide, yields sodium ethylbenzeneorthosulphonic acid, which crystallises with 1 mol. of water. The orthosulphonic chloride is an oil; the orthosulphonamide melts at 97°. The acid obtained on heating the sulphonic chloride with water at 140° crystallises in white, deliquescent prisms. When it is heated at 100°, either in a tube through which a current of dry air passes, or in an open dish, it is rapidly converted into the para-acid. This change is unaccompanied by the liberation of more than a mere trace of sulphuric acid.

*38. "β-Ethoxynaphthalenesulphonic acids. The arrest of isomeric change at an intermediate stage." By Arthur Lapworth.

Armstrong and Amphlett have shown (these Proceedings, 1887, 147) that when a solution of β-ethoxynaphthalene in carbon bisulphide is sulphonated by means of chlorosulphonic acid, at the ordinary temperature, two sulphonic acids are formed, one of which—the minor product—was proved to be 2 : 3′-ethoxynaphthalenesulphonic acid; they expressed the opinion that the major product was probably the 2 : 1′-acid, and showed that when the original product of sulphonation was heated merely on the water bath this acid, with the greatest ease, underwent conversion into the isomeric 2 : 3′-acid.

Subsequently Percival, in like manner (*ibid.*, 1889, 73), obtained two corresponding acids from β-methoxynaphthalene, and showed that in this case also the one was convertible into the other by mere heating on the water bath. He, however, made the remarkable observation that one of the products (it was presumed that there were but two) was hydrolysed with extreme facility, a behaviour not noticed in the case of the ethoxy compounds.

These observations have served to suggest experiments, which the author has undertaken, at Professor Armstrong's request, with the object of extending the knowledge of such derivatives, and also of obtaining additional information as to the course of change on continued sulphonation. It was to be supposed that this would be more readily gained than in the case of β-naphthol itself, as it is possible to prepare crystalline sulphochlorides, &c., from ethoxy- and methoxy-acids, whilst the naphtholsulphonic acids can only be characterised by means of their salts. This anticipation has been fully confirmed. In the first place, Armstrong and Amphlett's inference that the chief product from β-ethoxynaphthalene is probably the 2 : 1′-acid was confirmed by ethylating 2 : 1′-β-naphtholsulphonic acid; an ethoxy-acid was thus obtained, yielding a sulphochloride, amide and anilide identical with those derived from the unstable acid produced on sulphonating β-ethoxynaphthalene at the ordinary atmospheric temperature.

2 : 1′-β-Ethoxynaphthalenesulphonic chloride, $C_{10}H_7(OEt)SO_2Cl$, crystallises in large, shortened, monosymmetric prisms melting at 93°; the corresponding amide crystallises in needles melting at 165°; and the anilide forms magnificent, orthorhombic prisms melting at 158°.

On nitrating potassium 2 : 1′-β-ethoxysulphonate, it is converted into a mononitro-sulphonic *acid*, which crystallises from nitric acid in shining needles. The sulphochloride of this nitro-acid, which may also be prepared directly from the 2 : 1′-ethoxysulphochloride, melts at 155°; the amide at 173·4°.

2 : 3′-Ethoxynaphthalenesulphochloride crystallises in remarkably well-developed needles or tables belonging to the anorthic system, melting at 107·5°; the amide forms needles melting at 183°; the anilide small prisms melting at 152—153°.

1 : 2-Bromo-β-ethoxynaphthalene, which crystallises in small plates melting at 66°, yields practically nothing but 1-bromo-2 : 3′-sulphonic acid on sulphonation by means of chlorosulphonic acid. The same acid is obtained on brominating the 2 : 3′-ethoxysulphonic acid. The potassium salt of the acid is sparingly soluble in water, and is isomorphous with the corresponding β-naphthol and β-methoxy salts. The bromosulphochloride crystallises in tables melting at 131—132°; the amide in small, pyramidal crystals melting at 191°.

Potassium 2 : 3′-β-ethoxynaphthalenesulphonate is converted into a sparingly soluble mononitro-*salt* on nitration. The corresponding chloride crystallises in anorthic plates melting at 146°; the amide is especially characteristic, crystallising in beautiful, glistening prisms or needles melting at 218°.

2 : 2′-Ethoxynaphthalenesulphonic acid, prepared by ethylating the acid first described by Weinberg, yields a sulphochloride crystallising in plates, which are either rhombic or monoclinic; it melts at 103°. The amide crystallises in needles melting at 172°. The anilide, which is the most characteristic compound, forms monoclinic pyramids of large size, melting at 153°.

On studying the products from β-methoxynaphthalene, it was found that the acid which undergoes hydrolysis so readily is not the 2 : 1′-acid, which, when separated, proved to be stable in solution; it followed, therefore, that three acids were formed, not two, as had been previously supposed, and it was probable that one of these was the 2 : 1-acid, as the corresponding naphthol acid is known to undergo hydrolysis very readily. Subsequent observations have justified this conclusion.

The chloride from the the 2 : 3′-methoxy acid forms prisms which melt at 93°; an amide, crystallising in needles, which melt at 199°; and an anilide, crystallising in silky needles, melting at 79—80°.

The sulphochloride of the 2 : 1′-methoxy acid, like the corresponding ethoxy compound, crystallises in large, monoclinic prisms, or plates, melting at 137°; the amide crystallising in needles which melt at 153°, and the anilide crystallising in anorthic tables melting at 196°.

When the chlorides of these acids are heated or distilled, either alone or with phosphorus pentachloride, they do not yield the corresponding chloro-derivatives of naphthol, but either suffer complete decomposition or undergo chlorination.

On disulphonating ethoxynaphthalene at the atmospheric temperature, a very mixed product was obtained, from which it was found possible to isolate the disulphonic acids only after the expenditure of much time and labour. A surprising amount of 2·3′-salt accompanied the 2·1′-sulpho salt.

Only one disulphonic acid is formed in any appreciable quantity; this gives salts which, on the whole, are badly characterised, but yields a chloride of a well defined character. This crystallises from benzene in large transparent monoclinic crystals which contain $1\frac{1}{3}$ mol. of benzene of crystallisation, and melt when heated quickly at 51°. The chloride itself forms ill-defined plates melting at 10° C; the amide crystallises in needles melting at 253—254°, the anilide anorthic plates melting at 127°.

In order to determine the nature of this disulphonic acid, solutions of the 2·1′ and 2·3 -sulphonic chloride in warm chloroform were separately sulphonated with SO_3HCl, a novel method which has been found to afford most satisfactory results; on adding water to the products the sulphonated sulphochlorides at once dissolve, hydrolysis occurring immediately.

The 2·1′-sulphochloride yields an acid which was found to be identical with that produced on ethylating 2 : 1′ : 3′-β-naphtholdisulponic acid. Both products gave a sulphochloride crystallising in monoclinic prisms melting at 158° and the same amide and anilide.

The disulphonic acid from the 2·3′-disulphochloride on the other hand was found to be identical with the acid formed directly from ethoxynaphthalene, and as it was different from the 2 : 1′ : 3′-disulphochloride the conclusion was arrived at that the constitution was EtO⁚S⁚S = 2 : 1 : 3′. If such be the case, it follows that the first product of sulphonation of ethoxynaphthalene must be the 2-1-acid.

This result therefore led the author to sulphonate ethoxynaphthalene at as low temperature as possible by adding the chlorosulphonic acid to a solution cooled by a weak freezing mixture; the product was found to consist practically entirely of the 2 : 1-acid. On allowing the product to stand, however, merely at the ordinary temperature, during only about 12 hours, it was found that it underwent change chiefly into the isomeric 2 : 1′-acid, a small proportion of the 2 : 3′-acid being also formed. As the 2 : 1-acid is very easily hydrolyzed the separation of methoxynaphthalene observed by Percival is easily accounted for.

Judging from the manner in which the 2 : 1′-acid is thus formed, it is difficult to avoid the conclusion that its production from the 2 : 1-acid is due to direct isomeric change; and if it be supposed that the production of the 2 : 3′-acid is due to further isomeric change, this would appear to be the first case in which the arrest of isomeric change at an intermediate stage has been observed.

2 : 1-Ethoxynapthalenesulphonic chloride crystallises in long needles

melting at 115—116°, its amide forms monoclinic prisms melting at 158° and the anilide is also monoclinic, crystallising in large pyramids melting at 187°. The sulphonic group is at once displaced by the action of either nitric acid or bromnie.

2 : 3 : 3′-Ethoxynaphthalenedisulphonic acid, prepared by ethylating the corresponding naphthol acid, yields a chloride crystallising in ill-defined plates melting at 121°.

It is proposed to complete the series of ethoxysulphonic acids. The behaviour of α-ethoxynaphthalene will form the subject of a later communication.

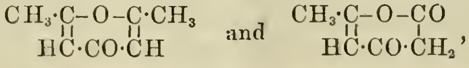
Discussion.

The President said that it was very noteworthy that Dr. Moody had failed to corroborate the statements of all previous workers with ortho- and metaxylene, ethylbenzene and methoxy- and ethoxybenzene, finding that none of these gave isomeric acids on sulphonation : having taken the very greatest pains to purify the materials he had used, he had not been misled by impurities. The readiness with which the ortho acids in all cases underwent change was remarkable, but most remarkable of all was the difference which he had established between methylbenzene (toluene) and ethylbenzene. The non-appearance of ortho-acid when the latter was sulphonated was probably to be accounted for by the extreme readiness with which the ortho-acid, conceivably the initial product of sulphonation, underwent "isomeric change," but whatever the explanation, the observation of so striking a difference in the behaviour of homologous methyl and ethyl derivatives was of great interest.

Mr. Lapworth's discovery that it was possible to arrest "isomeric change" at an intermediate stage was a very remarkable one; such results were of extreme importance as furnishing the materials required for the discussion of the mechanism of isomeric change.

39. "Some oxypyridine derivatives." By Miss A. P. Sedgwick, and N. Collie, Ph.D.

The authors have made a number of pyridine compounds from the derivatives of dehydracetic acid. The original object of the research was to produce as many oxypyridine derivatives as possible, whose constitutional formulæ would be known. Two substances, dimethyl pyrone and the lactone of triacetic acid,

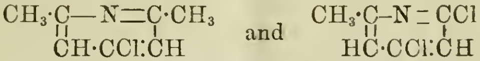


$$\begin{array}{c} CH_3\cdot C-O-C\cdot CH_3 \\ \| \qquad\quad \| \\ HC\cdot CO\cdot CH \end{array} \quad \text{and} \quad \begin{array}{c} CH_3\cdot C-O-CO \\ \| \qquad\quad | \\ HC\cdot CO\cdot CH_2 \end{array},$$

are not only easily prepared from dehydracetic acid, but at the same time easily pass into pyridine compounds when treated with ammonia.

The position of the oxygen atoms in the pyridine ring is also known. Oxy-pyridines are substances which possess all the marked and characteristic properties of phenols and quinones, but up to the present we are only acquainted with a very few of these compounds.

The pyridine derivatives, used by the authors as a starting point in the research, were *γ-chloro-αα′-dimethyl pyridine*, and *αγ-dichloro-α′-methyl pyridine*,



$$\begin{matrix}\mathrm{CH_3{\cdot}C{-}N{=}C{\cdot}CH_3}\\ \mathrm{CH{\cdot}CCl{:}CH}\end{matrix}\quad\text{and}\quad\begin{matrix}\mathrm{CH_3{\cdot}C{-}N{=}CCl}\\ \mathrm{HC{\cdot}CCl{:}CH}\end{matrix}\ .$$

By the action of dilute permanganate of potash on the first of these, two acids were obtained. The first, *γ-chloro-αα′-pyridine dicarboxylic acid*, is sparingly soluble in water, but crystallises well from acetic acid with 1 mol. of water of crystallisation; when heated it chars at about 220° without melting. A very characteristic reaction of this substance is the production of a brilliant cherry-red coloration with ferrous sulphate.

γ-Oxy-αα′-pyridinedicarboxylic acid or Chelidamic acid.—This substance was produced from the foregoing acid by careful fusion with potash. It possessed all the properties of chelidamic acid, prepared from chelidonic acid; when it is heated to 260°, carbon dioxide is copiously evolved, *γ-oxypyridine*, m. p. 66°, being formed.

α-Methyl-γ-chloro-α′-pyridinecarboxylic acid.—This is the second acid which is produced when γ-chlorolutidine is oxidised with potassium permanganate: it is more soluble in water than the first acid. Its m. p. is 93°; it crystallises in long needles without water of crystallisation. When strongly heated it decomposes yielding *γ-chloro-picoline.* This compound is a liquid, b. p. 162·5—163·5°. It is possibly the same as a chloropicoline noticed by Ost (*Ber.*, 16, *Ref.*, 1374), which he obtained by reducing pentachloropicoline with tin and hydrochloric acid. When γ-chloropicoline is oxidised with permanganate of potash it is converted into *γ-chloropicolinic acid*, m. p. 194—195°, and this acid when fused with potash yields *γ-oxypicolinic acid*, which melts at 263—264°. When the lactone of triacetic acid is heated with ammonia dioxypicoline is formed; the compound can be quantitatively converted into *αγ-dichloro-α′-methyl pyridine.* This chloride on oxidation with permanganate is converted into *αγ-dichloropicolinic acid*, m. p. 101—102°, which crystallises in long needles. When heated it does not yield dichloro-pyridine, but suffers complete decomposition. If it is boiled with sodium ethylate it is completely converted into *αγ-ethoxypicolinic acid*, which melts at 93—95°, and this substance yields *αγ-dioxypicolinic acid* when boiled with fuming hydriodic acid. This oxy-acid melts at 270—273°, and is isomeric, though not identical with, another dioxypicolinic acid, comenamenic acid. Several attempts were made to prepare αγ-dioxypyridine, but without success. *αγ-Diethoxypicoline* was made from dichloropicoline by boiling it with sodium ethylate. It is a sweet smelling oil, which boils between 238—240°.

40. "On the colouring principle of 'Toddalia aculeata' and 'Evodia meliæfolia.'" By A. G. Perkin and J. J. Hummel.

Toddalia aculeata is an Indian plant belonging to the Rutaceæ. Its root bark is used in Madras as a yellow dye-stuff; it also possesses valuable medicinal qualities. The authors find that the colouring matter is berberine, contrary to the statement of Flückiger and Hanbury, who were unable to detect this alkaloid.

Evodia meliæfolia, belonging to the same natural order, is a tree growing in China and Japan, whose bark is largely employed in medicine and in dyeing. The authors confirm previous statements that the bark contains berberine.

Comparative dyeing experiments on wool indicated that Evodia and Toddalia bark possess the same tinctorial power as a 3 per cent. solution of berberine hydrochloride.

41. "Some ethereal derivatives of sarcolactic acid." By Percy Frankland, Ph.D., B.Sc., F.R.S., and James Henderson, B.Sc.

The authors have prepared sarcolactic acid in quantity by the fermentation method previously described by Percy Frankland and MacGregor (Trans., 1893, 1028). Of this sarcolactic acid they have prepared the following derivatives: methylic and ethylic sarcolactate, methylic and ethylic acetylsarcolactate, ethylic benzoylsarcolactate.

The optical and other constants determined are given in the following table.

Ethereal salts.	Boiling point (uncorr.).	Relative density, 15°/15°.	Observed rotation at 15° C., α_D. (198·4 mm. tube).	Specific rotation, $[\alpha]_D$.	Molecular rotation, $\frac{M\,[\alpha]_D}{100}$	Molecular deviation, $[\delta]_D = \frac{\alpha}{L}\sqrt[3]{\frac{M}{d}}$.	Product of asymmetry (P × 10^6).
Methylic sarcolactate	143°—145	1·1017	−15°·00	−6°·8	−7°·13	−34°·4	79°·16
Ethylic sarcolactate	152—154	1·0414	−17·90 (at 16·5° C.)	−8·6	−10·22	−43·7	73·84
Methylic acetylsarcolactate....	170—171·5	1·0957	−94·36	−43·41	−63·38	−242·9	0
Ethylic acetylsarcolactate	179·5—180·5	1·0527	−86·62	−41·47	−66·35	−232·9	198·6
Ethylic benzoylsarcolactate....	154—155·5 (15 mm.)	1·1164 (14·9°/14·9°)	+49·2	+22·22	+49·33	+144·7	416·2

The relationship between these and the corresponding derivatives of active glyceric acid is discussed. The more important points are

1. The small effect on the rotation of substituting ethyl for methyl in the lactate compared with that in the glycerate.

2. The much greater increase in the rotation effected by acetylating the lactate than by diacetylating the glycerate.

3. The reversal of the sign of rotation by the introduction of the benzoyl group. This ;is also the effect of introducing two benzoyl groups into the glycerates.

4. The comparatively slight difference in rotation exhibited by the methylic and ethylic lactates probably points to the latter exhibiting the "maximum" in this series of ethereal salts; the maximum, as calculated from the product of asymmetry, should be exhibited by the methylic salt; in the glyceric series the calculated maximum is exhibited by the propyl, and actually by the tributyl compound. The coincidence in both cases is, therefore, probably similar.

5. The ethereal salts of glyceric acid exhibit a diminishing density in ascending the series from the methylic to butylic; the diacetylglycerates have lower densities than the corresponding glycerates, excepting in the case of the heptyl and octyl compounds, of which the diacetyl glycerates have a greater density than the corresponding glycerates, or, in other words, the density curves of the glycerates and diacetylglycerates cross at the maximum (the butyl compound). The same phenomenon is repeated in the case of the lactates; methylic acetyllactate has a lower density than methylic lactate; ethylic acetyllactate has a higher density than ethylic lactate.

6. This intersection of the density curves is also in both cases attended with a remarkable change in the optical relationship, which may be stated thus: the greater the diminution in the density effected by acetylating, the greater is the increase in the rotation produced by this constitutional change; and when the effect of acetylating is to increase the density, the increment in rotation is markedly less than in those cases in which the density is diminished by the process. This applies also to both glycerates and lactates.

7. The effect of benzoylating is to increase the density, whilst at the same time it enormously diminishes the rotation, as well as reversing the sign of the latter. This again holds good for both glycerates and lactates.

42. "Electrolysis of potassium allo-ethylic camphorate." By James Walker, D.Sc., and James Henderson, B.Sc.

The chief products obtained on electrolysing potassium allo-ethylic camphorate are the ethylic salts of an unsaturated acid,

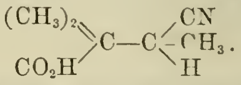
$C_9H_{14}O_2$, and of a dibasic saturated acid, $C_{18}H_{30}O_4$. These acids have been named *allo-campholytic* and *allo-camphothetic* acids respectively. The former acid gives a liquid dibromide, and can be converted into the isomeric campholactone of Fittig and Woringer. It is not identical with lauronolic acid, which also yields campholactone on similar treatment. The isolauronolic acid of Kœnigs and Hœrlin is identical with isocampholytic acid. The results obtained indicate that camphoric acid contains the group $\cdot\dot{C}H\cdot CH(COOH)\cdot\dot{C}(COOH)$.

43. "Trimethylsuccinic acid." By W. A. Bone, M.Sc., Ph.D., and W. H. Perkin, jun., Ph.D., F.R.S.

For some time the authors have been working with this acid and the isomeric dimethylglutaric acids, and, although their experiments are not yet complete, the recent appearance of a paper by Auwers on the same subject (*Ber.*, **28**, 263) renders the publication of this short notice necessary.

There has been a good deal of discussion as to whether trimethylsuccinic acid exists in one or two modifications. The authors have prepared this acid by two different methods, viz. (1) by the action of ethylic α-bromisobutyrate on the sodium derivative of ethylic α-cyanopropionate (Zelinsky, *Ber.*, **24**, 468); (2) and by the action of ethylic α-bromisobutyrate on the sodium derivative of ethylic methylmalonate dissolved in xylene at 180° (Bischoff, *Ber.*, **24**, 1041). The products were in each case hydrolysed, and the acid heated at 200°. The authors find that one and the same trimethylsuccinic acid is always formed, and that when pure this melts at 152°; and they are able to confirm the results recently obtained by Auwers, which differ materially from those described by Zelinsky (*ibid.*), Bischoff (*ibid.*), and Helle (*Inaug. Diss.*, Bonn, 1893).

Trimethylsuccinic acid is characterised by yielding a very insoluble calcium salt, which affords a convenient method for separating it from the isomeric dimethylglutaric acids, which are always formed in the above interactions. When heated with acetic anhydride, trimethylsuccinic acid yields an anhydride melting at 38—39°.

During the course of their experiments, the authors have also obtained cyanotrimethylpropionic acid,  $\begin{matrix}(CH_3)_2\\ CO_2H\end{matrix}\!>\!C-C\!<\!\begin{matrix}CN\\ CH_3\\ H\end{matrix}$. This acid crystallises in colourless needles, melting at 126°, and it is characterised by yielding a sparingly soluble ammonium salt, which crystallises from water in long, colourless needles. Acetic anhydride converts cyanotrimethylpropionic acid into a crystalline substance melting at 65°, which is at present under investigation. On hydrolysis with concentrated hydrochloric acid, cyanotrimethylpropionic acid yields trimethylsuccinic acid, which shows that it must have the constitution represented above.

A description of the results recently obtained in the investigation of the isomeric symmetrical dimethylglutaric acid, which is not yet concluded, is reserved for a future paper.

44. "New isomeric sulphonic chlorides derived from camphor." By F. Stanley Kipping, Ph.D., D.Sc., and William J. Pope.

In our first paper on the sulphonic derivatives of camphor (Trans., 1893, **63**, 548) the separation of dextrorotatory camphor sulphonic chloride and of the corresponding optically inactive compound was described, and it was mentioned that the crude oily product obtained by the interaction of sodium camphorsulphonate and phosphorus pentachloride contained other crystalline compounds of unknown composition. As it seemed possible that these bye-products might prove to be interesting derivatives of camphor, their investigation has been continued: two new crystalline substances have now been isolated from the mixture.

The compounds in question are isomeric sulphonic chlorides of the composition $C_{10}H_{14}Cl{\cdot}SO_2Cl$, and both are optically inactive; we propose for the present to call them *chlorocamphenesulphonic chlorides*, at any rate until further study shows that they are not, as we believe them to be, camphene derivatives.

α-Chlorocamphenesulphonic chloride may be obtained in beautiful, massive, transparent crystals, but it is much more readily soluble than either of the camphorsulphonic chlorides in all ordinary solvents, and dissolves freely even in boiling light petroleum (b. p. 40—50°); it melts, not quite sharply, at 83—84°, and appears to be dimorphous, as, when the liquefied substance is rapidly cooled it solidifies to an opaque mass which does not melt until 86—87°.

α-Chlorocamphenesulphonamide, $C_{10}H_{14}Cl{\cdot}SO_2{\cdot}NH_2$, is obtained on shaking the sulphonic chloride with cold concentrated ammonia; it crystallises from dilute alcohol in transparent plates melting at 161—162°, and is only sparingly soluble in water.

α-Dichloracamphene, $C_{10}H_{14}Cl_2$, is formed in large quantities when α-chlorocamphenesulphonic chloride is heated for a short time at 160—170°; it crystallises from dilute alcohol in fern-like forms melting at 72—73°, and is readily volatile in steam.

β-Chlorocamphenesulphonic chloride appears to be present in the crude oily product in much smaller quantities than the corresponding α-compound, and, being much more readily soluble than the latter, it is isolated only with difficulty; it dissolves freely even in cold light petroleum (b. p. 30—40°) from which it crystallises in large, transparent plates which become opaque when heated gently in contact with the mother liquor; its melting point is 77—78°.

β-Chlorocamphenesulphonamide, $C_{10}H_{14}Cl{\cdot}SO_2{\cdot}NH_2$, crystallises from dilute alcohol in plates, and melts at 156—157°.

When the β-sulphonic chloride is heated at about 160° it is rapidly decomposed, sulphur dioxide being evolved; the main product is a colourless, very volatile, pleasant-smelling oil, but a small quantity of a crystalline substance is also obtained.

In their behaviour, when heated, these two chlorocamphenesulphonic chlorides evidently resemble the sulphonic derivatives of camphor, which, as we have recently shown, are readily converted into halogen derivatives, losing sulphur dioxide. The exact manner in which these two bye-products are formed is not yet known, but it seems probable that they are produced by the action of phosphorus pentachloride on camphorsulphonic chloride.

March 27th, 1895. Anniversary Meeting. Dr. Armstrong, President, in the Chair.

The President, in opening his address, referred to the fact that its delivery marked the close of an official connection with the Society maintained during 20 years—a period of great activity in the history of the Society during which the number of Fellows had increased from 800 to nearly 2,000.

The first subject considered was the Faraday lectureship, which, he remarked, had been described as "an institution that in its most characteristic features is without parallel elsewhere," by Professor Odling, who, moreover, had said "that having regard to the great name with which it is associated, we cannot doubt that the nomination to this lectureship will ever be held in high esteem." This very fact made the appointment one which occasions great perplexity. Having failed to induce Professor Emil Fischer to deliver the lecture, the Council had been led to fully discuss the matter and to arrive at the conclusion that it would be desirable to break through the practice originally initiated by the Council, and hitherto adhered to, of inviting only foreigners to deliver the lecture. Since this decision was arrived at, circumstances had arisen which had led to an even more novel departure. All were aware that Lord Rayleigh and Professor Ramsay had recently successfully effected the separation of a hitherto unrecognised constituent from the atmosphere, a discovery which was justly regarded as one of the most remarkable ever made in chemistry—but this was no chance discovery. On the contrary, it was the outcome of labours carried out with unwearied perseverance and patience and with consummate skill by Lord Rayleigh during many years past. After tracing the history of the discovery, the President proceeded to say that no chemist could fail to be impressed by Lord Rayleigh's work. Recognising its extreme value, the Council had decided to appoint Lord Rayleigh Faraday lecturer, and to request his acceptance of the medal in recognition of the important service which he had rendered to chemical science by his discovery of argon. They did not ask that he should give a lecture, but made the award of the medal in this special manner in order to mark their sense of the value of his labours and especially of the example he had set. There was, however, reason to hope that Lord Rayleigh will be prepared to address the Society on the subject of argon.

The PRESIDENT then presented the Faraday Medal to Lord Rayleigh "in recognition of the services he had rendered to chemical science by the discovery of Argon."

LORD RAYLEIGH said that, in returning his thanks to the Society, he was somewhat embarrassed, because he felt that there ought to be another standing at his side. It was true that his researches, to which the President had referred, upon the densities of gases had rendered it almost certain that a new gas of some sort was concerned, and probable that the new gas was in the atmosphere. But from this point to the isolation and examination of argon was a long step, and the credit for it must be shared equally between Professor Ramsay and himself. In some quarters there had been a tendency to represent that antagonism existed between chemists and physicists in the matter, though such a thought never entered his mind. Professor Ramsay was a chemist by profession, while he himself had dabbled in chemistry from an early age, and had followed its development with a keen interest.

Being called on by the President, Professor Ramsay made the following communication of the discovery of helium in clèveite.

"In seeking a clue to compounds of argon, I was led to repeat experiments of Hillebrand on clèveite, which, as is known, when boiled with weak sulphuric acid, gives off a gas hitherto supposed to be nitrogen. This gas proved to be almost free from nitrogen; its spectrum in a Plücker's tube showed all the prominent argon lines, and, in addition, a brilliant line close to, but not coinciding with, the D lines of sodium. There are, moreover, a number of other lines, of which one in the green-blue is especially prominent. Atmospheric argon shows, besides, three lines in the violet which are not to be seen, or, if present, are excessively feeble, in the spectrum of the gas from clèveite. This suggests that atmospheric argon contains, besides argon, some other gas which has as yet not been separated, and which may possibly account for the anomalous position of argon in its numerical relations with other elements.

"Not having a spectroscope with which accurate measurements can be made, I sent a tube of the gas to Mr. Crookes, who has identified the yellow line with that of the solar element to which the name 'helium' has been given. He has kindly undertaken to make an exhaustive study of its spectrum.

"I have obtained a considerable quantity of this mixture, and hope soon to be able to report concerning its properties. A determination of its density promises to be of great interest."

Mr. Crookes then gave the following account of the spectrum of the gas from clèveite.

"By the kindness of Professor Ramsay I have been enabled to examine spectroscopically two Plücker tubes filled with some of the gas obtained from the rare mineral clèveite.* The nitrogen had been removed by 'sparking' over alkali. On looking at the spectrum, by far the most prominent line was seen to be a brilliant yellow one, apparently occupying the position of the sodium lines. Examination with high powers showed, however, that the line remained rigorously single when the sodium lines would be widely separated. On throwing sodium light into the spectroscope simultaneously with that from the new gas, the spectrum of the latter was seen to consist almost entirely of a bright yellow line a little to the more refrangible side of the sodium lines, and separated from them by a space a little wider than twice that separating the two sodium components from one another. It appeared as bright and as sharp as D_1 and D_2. Careful measurements gave its wave-length 587·45, the wave-lengths of the sodium lines being D_1 589·51 and D_2 588·91. The differences are therefore—

	Wave-lengths.	Differences.
D_1	589·51	0·60
D_2	588·91	1·46
New line	587·45	

"The spectrum of the gas is therefore that of the hypothetical element helium, or D_3, the wave-length of which is given by Ångstrom as 587·49 and by Cornu as 587·46.

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* Clèveite is a variety of uraninite; chiefly a uranate of uranyle, lead, and the rare earths. It contains about 13 per cent. of the rare earths, and about 2·5 per cent. of a gas said to be nitrogen (*Bull. U. S. Geol. Survey*, **78**, 43—79).

"Besides the helium line, traces of the more prominent lines of argon were seen.

"Comparing the visible spectrum of the new gas with the band and line spectrum of nitrogen they are almost identical at the red and blue end, but there is a broad space in the green where they differ entirely. The helium tube shows lines in the following positions.

	Wave-length.	
(*a.*) D_3, yellow	587·45	Very strong. Sharp.
(*b.*) Yellowish green	568·05	Faint. Sharp.
(*c*) Yellowish green	566·41	Very faint. Sharp.
(*d.*) Green	516·12	Faint. Sharp.
(*e.*) Greenish blue	500·81	Faint. Sharp.
(*f.*) Blue	480·63	Faint. Sharp.

"I have taken photographs of the spectrum given by the helium tube. At first glance the ultra violet part of the spectrum looks like the band spectrum of nitrogen, but closer examination shows considerable differences. Some of the lines and bands in the nitrogen spectrum are absent in that from the helium tube, whilst there are many fine lines in the latter which are absent in nitrogen. Accurate measurements of these lines are being made."

Continuing his address, the PRESIDENT said that the Society had lost an old and faithful servant in the collector, Mr. Hall, who last summer retired on a pension from the Society after being 25 years in its employ.

The opportunity had been taken to institute changes in the paid staff of the Society which had long been advocated by the officers but postponed mainly on financial grounds. A collector being no longer necessary, it had been decided to appoint an Assistant-Secretary, who should also act as assistant to the Treasurer and as Librarian. They had been successful in securing the services of Mr. Robert Steele, formerly a science master at the Bedford Modern School.

The fusion of the offices of Assistant-Secretary and of Librarian, effected with the object of securing the constant attendance of the Librarian, had led to the termination of Dr. Thorne's official connection with the Society; on behalf of the Council, he desired to express the warmest thanks to Dr. Thorne for the assistance he had rendered as Librarian since the death of Mr. Watts.

The numerical strength of the Society was as follows :—*

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* This statement has been corrected to March 31st, 1895.

Number of Fellows, March 31st, 1894		1962
,, ,, since admitted		118
		2080
Removed on account of non-payment of four annual subscriptions	24	
Do. three annual subscriptions	33	
Withdrawn	27	
Deaths	17	
		101
Number of Fellows, March 31st, 1895		1979
Foreign Members		30

These statistics were by no means satisfactory. Not only was the number admitted smaller than usual, one reason being that 23 who had been elected had failed to satisfy the conditions on which admission into the Society was granted, but an unusually large number had declined to comply with the Bye-laws and the Treasurer's just demands, and, therefore, were removed from the register. The names of those who have thus, of their own act, ceased to be Fellows of the Society are as follows :—

Four years' arrears :—Buch, C. von ; Cook, H. J. ; Chenhall, J. W. ; Chiddey, A. ; Cunningham, A. A. ; Donovan, H. T. ; Evans, G. T. ; Featherstone, W. B. ; Farquharson, A. C. ; Gregory, W. ; Gee, W. W. H. ; Holt, C. G. ; Haslam, A. R. ; Maybury, C. ; Moos, N. A. F. ; Morgan, A. F. ; McCalman, G. ; Porter, H. ; Stanley, T. W. ; Shaw, H. G. ; Tarn, A. ; Trinks, C. H. ; Wood, G. W. ; Wade, M. S.

Three years' arrears :—Broughton, F. ; Brunker, J. E. ; Bailey, R. D. ; Byrn, G. ; Barry, T. D. C. ; Belbin, T. St. J. ; Coleman, T. H. ; Davies, A. E. ; Davies, J. ; Gracey, R. ; Grey, W. T. ; Gerrans, B. H. ; Guthrie, F. B. ; Hori, E. ; Irons, H. E. J. ; Jenner, T. ; Kilpatrick, C. ; Knowles, J. ; Linnell, A. ; Luckett, A. H. ; Menzies, Rev. T. J. ; Mackay, A. ; Mayhew, E. W. A. ; Parry, J. ; Provis, J. ; Pike, A. E. ; Serre, C. A. ; Steedman, C. E. ; Sach, A. J. ; Tompkins, H. R. ; Whitlock, J. ; Wilkie, J. ; Wadsworth, G. H.

The following have withdrawn :—Auerbach, G. ; Bell, Sir W. J. ; Cortis, A. B. ; Day, A. W. ; Dott, D. B. ; Forth, H. ; Greenish, H. G. ; Hall, E. ; Jackson, J. R. ; Lauer, W. E. ; Lightbown, J. H. ; Mason, G. B. ; Müller, Prof. G. ; Oxford, Rev. A. W. ; Parker, G. L. ; Paterson, J. R. ; Peace, F. K. ; Peterson, F. W. ; Platts, K. ; Ray, W. ; Samuel, A. H. ; Shaw, H. D. ; Stavert, Rev. W. J. ; Stoker, H. ; Sutcliffe, S. ; Taylor, G. S. ; Venis, W.

The Society was fortunate in having been deprived of only 17 of its Fellows by death, viz.:—Ashwell, J. R.; Barratt, Alex.; Beauchamp, Maj.; Board, G.; Carteighe, J.; Dunne, B. L.; Gill, C. H.; *Hughes, F. R.; Johnson, F. R.; Morris, J. E.; Nason, Prof. H. B.; Salet, G.; Twining, A. H.; White, A.; Wright, C. A.; Evans, N.; Thornthwaite, W. H.

This list contains the name of one of the original Fellows of the Society, F. R. Hughes, so that now but one remains—Lord Playfair. The decease of Dr. Alder Wright at so early an age was especially to be regretted.

Three foreign members had died during the year—Marignac, v. Helmholtz, and Josiah P. Cooke. Prof. Cleve had undertaken to commemorate the work of the first of these, and especially to discuss the present state of our knowledge of the chemistry of the rare earths, a subject to which Marignac devoted particular attention. Prof. Fitzgerald, F.R S., in like manner had consented to deal with that part of the work of v. Helmholtz which was of interest to chemists, viz. electrolysis and the theory of vortex atoms.

Reference was made to a somewhat virulent outbreak of the blackballing mania which affected one of the elections. Having made special enquiries with reference to those who were rejected, he was satisfied, said the President, that they were, in the majority of cases, the victims of unjust prejudice.

The Assistant Secretary was engaged in verifying the register of Fellows, and as illustrating the difficulties, it might be mentioned that no fewer than 98 Life Fellows had not responded to the request for their present addresses. Moreover, the addresses of the following 10 Life Fellows and 11 others are unknown beyond question, journals sent to them having been returned through the post.

Chester, E. D.; Faye, M. H.; Frost, Robert; Hadkinson, John; Hoskins, A. P.; Looker, Percy; Millar, Jas.; Pollock, J. H.; Vacher, A.; Young, B.

Ordinary members:—Alexander, J.; Ashcroft, G. A.; Babington, P.; Brown, F. W.; Chantrell, P.; Coleman, J. B.; Cooke, A. W.; Golden, A. R.; Wallis, H. W.; Ward, T. A.; Wellington, S. N.

The number of communications made to the Society during the year was 132.

Eighty-three papers were published in the Transactions for 1894, occupying 1,039 pages; whereas in the preceding year 104 papers were published, occupying 1,432 pages.

The following were the statistics relating to the Abstracts.

	Pages.	No. of Abstracts.
PART I.		
Organic Chemistry	631	1105
PART II.		
General and Physical Chemistry		245
Inorganic Chemistry		218
Mineralogical Chemistry		99
Physiological Chemistry		163
Chemistry of Vegetable Physiology and Agriculture		99
Analytical Chemistry		328
Total in Part II	492	1152
Total in Parts I and II	1123	2257

The Index to the Transactions, Proceedings and Abstracts occupies 149 pages, and contains upwards of 11,000 entries.

Referring to the labours of the Editors in connection with the Transactions and Abstracts, the President said that not only the Council but all the Fellows must very fully recognise the great value of the work which is done for the Society by both gentlemen.

Taking into consideration the increase in the size of the Journal and its great value, the Council had resolved to increase the sale price to 40 shillings per annum after this year.

Among other topics, referrence was made to the issue of abstracts of physical papers by the Physical Society; also to the federation of the various Brewing Institutes, and the issue by them of a journal, which, besides original matter, was to contain abstracts of papers of special interest to those engaged in the brewing industry.

The technical portion of the address dealing with the ionic dissociation hypothesis and the correlation of structure with function, among other matters, having been taken as read:—

SIR FREDERICK ABEL proposed a vote of thanks to the President, coupled with the request that he allow his address to be printed. Dr. W. H. Perkin seconded the motion, which was carried by acclamation. The President having thanked the meeting,

Professor THORPE, the treasurer, gave an account of the balance sheet, which he laid before the Society, duly audited.

The receipts had been:—By admission fees and subscriptions, £4049; by sale of Journal and advertisements, £470 15*s.* 6*d.*; and by dividends on invested capital, £364 17*s.* 6*d.* The expenses had been: —On account of the Journal, £2757 5*s.* 3*d.*; on account of the Proceedings, £239 17*s.* 3*d.*; on account of the General Index, £112

19*s.* 2*d.*; on account of the Library, £319 4*s.* 2*d.*; the total expenditure being £4135 9*s.* 11*d.* Grants amounting to £197 had been made to Fellows from the Research Fund during the year.

Dr. GLADSTONE proposed that the thanks of the Fellows be tendered to the treasurer for his services during the past year; this motion was seconded by Mr. Carteighe.

The vote of thanks to the treasurer having been passed, Professor Tilden proposed a vote of thanks to the Council and officers.

Mr. Hehner supported the motion, which was adopted.

The Treasurer, in responding, proposed a vote of thanks to the auditors. Mr. Friswell seconded the motion, which was unanimously adopted, and acknowledged by Mr. Bevan.

Mr. Warrington proposed a vote of thanks to the Editor, Sub-Editor, and Abstractors, which was seconded by Dr. Wynne and carried. Mr. Groves briefly responded.

Scrutators were appointed, and a ballot was then taken for the election of officers and Council for the ensuing year; the following were subsequently declared elected:—

President: A. Vernon Harcourt, M.A., LL.D., D.C.L., F.R.S.

Vice-Presidents who have filled the office of President: Sir F. A. Abel, Bart., K.C.B., D.C.L., F.R.S.; H. E. Armstrong, LL.D., Ph.D., F.R.S.; A. Crum Brown, D.Sc., F.R.S.; W. Crookes, F.R.S.; E. Frankland, D.C.L., F.R.S.; Sir J. H. Gilbert, Ph.D., F.R.S.; J. H. Gladstone, Ph.D., F.R.S.; H. Müller, Ph.D., F.R.S.; W. Odling, M.B., F.R.S.; W. H. Perkin, LL.D., Ph.D., F.R.S.; Lord Playfair, K.C.B., Ph.D., F.R.S.; Sir H. E. Roscoe, LL.D., F.R.S.; W. J. Russell, Ph.D., F.R.S.; A. W. Williamson, LL.D., F.R.S.

Vice-Presidents: E. Atkinson, Ph.D.; Horace T. Brown, F.R.S.; F. R. Japp, M.A., Ph.D., LL.D., F.R.S.; Ludwig Mond, F.R.S.; C. O'Sullivan, F.R.S.; W. C. Roberts-Austen, C.B., F.R.S.

Secretaries: J. M. Thomson; W. R. Dunstan, M.A., F.R.S.

Foreign Secretary: Raphael Meldola, F.R.S.

Treasurer: T. E. Thorpe, LL.D., F.R.S.

Other Members of Council: P. P. Bedson, D.Sc.; B. H. Brough; H. B. Dixon, F.R.S.; Bernard Dyer, D.Sc.; R. J. Friswell; O. Hehner; F. S. Kipping, Ph.D., D.Sc.; H. McLeod, F.R.S.; W. A. Shenstone; T. Stevenson, M.D.; W. P. Wynne, D.Sc.; S. Young, D.Sc., F.R.S.

Anniversary Dinner. Wednesday, March 27, 1895. Professor H. E. Armstrong, F.R.S., President, in the Chair. Whitehall Rooms, Hôtel Métropole, 7.30 P.M.

The following Fellows and guests were present:—

Armstrong, Dr., *Chairman.*
Atkinson, Dr.

Balfour, The Rt. Hon. A. J., M.P.
Bevan, Mr. E.
Blackwell, Mr. T. F., *Master of the Salters' Company.*
Blount, Mr. Bertram.
Brierley, Mr. J. T.
Brown, Mr. Horace.
Bryce, The Rt. Hon. Jas., M.P., *President of the Board of Trade.*

Carteighe, Mr., *President of the Pharmaceutical Society.*
Chapman, Mr. A. C.
Chattaway, Dr.
Child, Mr. J. M.
Cockell, Mr. E. M.
Cooper, Mr. Albert.
Crookes, Mr. Jos.
Crookes, Mr. W.
Cross, Mr. C. F.

Dewar, Prof.
Dick, Mr. A. B.
Down, Mr. F. J.
Dunstan, Prof., *Hon. Secretary.*
Dyer, Dr. B.
Dyer, Mr. W. Thisleton, C.B., *Director Royal Gardens, Kew.*

Fairley, Mr. T.
Formoy, Mr., J. P.
Frankland, Prof. Percy.
Friswell, Mr. R. J.

Gardiner, Dr. H. J.
Gilbert, Sir H.
Gladstone, Dr. J. H.
Gordon, Mr. J. G.
Green, Mr. A. G.
Greenaway, Mr. A. J., *Sub-Editor.*
Griffith, Mr. G.
Groves, Mr. C. E., *Editor.*

Harcourt, Mr. A. Vernon, *President Elect.*
Hare, Mr. A. T.
Harvey, Dr. J. S.
Harvey, Mr. R. M.
Hehner, Mr. Otto.
Hopkins, Mr. F. G.
Howard, Mr. D. L.
Howard, Mr. Walter.
Howie, Mr. W. L.

Jackson, Mr. H.

Karslake, Mr. Lewis.
Kellner, Dr. W.
Kemp, Mr. W. J.

Laws, Mr. J. Parry.
Lockyer, Prof. Norman, C.B.

Macnab, Mr. W.
Magnus, Sir P.
Masters, Mr.
Masters, Mr. W.
McLeod, Prof.
Meldola, Prof., *Foreign Secretary.*
Messel, Dr.
Myood, Dr. G.
Morris, Dr. G. H.
Müller, Dr. Hugo.
Muter, Mr. W.

Nagel, Mr. D. H.
Nathan, Capt. F. L.
Newlands, Mr. B. E. R.
Newlands, Mr. J. A. R.

Odling, Prof.

Page, Mr. F. J. M.
Perkin, Dr. W. H.
Pickering, Mr. S. U.
Ping, Mr. W.
Prideaux, Sir Walter, *Clerk of the Goldsmiths' Company.*

Pullar, Mr. R.

Ramsay, Prof.
Rayleigh, The Right Hon. Lord, *Secretary of the Royal Society.*
Read, E. J.
Reynolds, Prof. Emerson.
Roberts, Sir Owen, *Clerk of the Clothworkers' Company.*
Rodger, Mr. J. W.
Roscoe, Sir Henry E., M.P.
Rücker, Prof., *Treas. British Association.*
Russell, Dr. W. J., *President of the Institute of Chemistry.*
Russell, Mr.

Salamon, Mr. A. G.
Savage, Mr. T.
Shenstone, Mr. W. A.
Siemens, Mr. C. von
Smith, Mr. Lavers, *Master of the Cordwainers' Company.*
Smithells Prof.
Soper, Mr. A. L., *Sec. City and Guilds Institute.*
Spiller, Mr. Geo.
Spiller, Mr. Wm.
Steele, Mr. R., *Assistant Secretary and Librarian.*
Stevenson, Dr., *President of the Society of Public Analysts.*
Symons, Dr. W. H.

Thomson, Prof., *Hon. Secretary.*
Thorne, Dr. L. T.
Thorpe, Prof., *President of the Society of Chemical Industry.*
Tilden, Prof.
Tookey, Mr. Chas.
Tutton, Mr. A. E.

Vautin, Mr. Cl.
Voelcker, Dr. J. A.

Wynne, Dr.

The following toasts were proposed :—

By the President.

1. Her Most Gracious Majesty the Queen.
2. The Houses of Parliament, coupled with the name of the Right Hon. James Bryce, M.P., President of the Board of Trade.

By the Right Hon. A. J. Balfour, M.P.

3. Prosperity to the Chemical Society, coupled with the name of the President.

By Mr. A. G. Vernon Harcourt, F.R.S., President Elect.

4. Learned Societies, coupled with the name of the Right Hon. Lord Rayleigh, Secretary of the Royal Society.

By Sir Henry Roscoe, M.P., F.R.S.

5. The Visitors, coupled with the names of Sir Owen Roberts, Professor Rücker, F.R.S.

Dr. W. J. Russell, F.R.S., President of the Institute of Chemistry.

6. The President.

By the President.

7. The Secretaries, coupled with the name of Prof. J. Millar Thomson.

Mr. Balfour, in proposing the toast of the evening, said, Mr. President, the President of the Board of Trade reminded us that his department was brought into closest relation with science, almost every day, in relation to the great practical questions with which it has to deal. I think he will probably agree with me when I say that we who are engaged in the work of every day political conflict cannot boast that we are in the position of using science as the handmaid to great national purposes, or that we have the power to turn it and direct its great powers whither we will. For my own part, though the last thing I wish to do is to suggest that the work of a practical politician is other than a work which taxes the highest qualities of a man, still I have to admit on looking back at the history of civilization, that if we want to isolate the causes which more than any other conduce to the movements of great civilised societies, you must not look to the politician of the hour on whom it may be all eyes are fixed: you must look to those, often unknown by the multitude, whose work, it may be, is never properly realised by the mass of their countrymen till after they are dead. You must look at them, and at their labours, to find the great sources of social movement. We, who, are carrying on a work, which I hope is not useless, which, I am sure, receives its full meed of public recognition and public gratitude, do, after all, not belong to that class to which the community is most beholden for all that is to improve the lot of man upon earth. It is to those who, very often with no special practical object in view, casting their eyes upon no other object than the abstract truth, and the pure truth which it is their desire to elucidate, penetrate ever further and further into the secrets of nature, and provide the practical man with the material upon which he works. Those are the men who, if you analyse the social forces of their ultimate units, those are the men to whom we owe most, and to such men, and to produce such men, and to honour such men, and to educate such men, the Society whose health I am now proposing devotes its best energies. Mr. President, I do not think that Englishmen need feel that they have been behind the rest of the world in evolving those root ideas which are the source of great discoveries, which are themselves great discoveries and the source and root of other great discoveries. It may be, however,—I think it is the fact—that though, as a nation, we have been as productive as other nations, I put it modestly, in the men of genius who have made these fundamental discoveries, I do not think, as a nation, we have sufficiently realised how great a part theory, how great a bearing theory, in these modern days, must necessarily have upon practice if we are to keep abreast of the rest of the world. We have produced great theorists, none greater; we have produced men of great practical genius, none greater. I am not sure, however, that at this moment we are not behind one, at least, of the great nations of the continent, perhaps more than one, in the art of combining theory and practice, in the art of so welding together into one organic and self-supporting whole the man of genius who, at one end of the scale, discovers the new laws of nature which have to be applied, and the man of practice, at the other end, whose business it is to turn those discoveries to account. I do not venture upon a subject on which, after all, I am but little competent to speak as an expert, to develope the matter at greater length, but I should like to do what I can to dispel the prejudice. which certainly exists at this moment in many influential quarters, against technical education properly understood. Technical education, properly understood, suffers greatly under technical education improperly understood. and there is so much nonsense talked upon this subject, there is so much money uselessly spent, there are so many things taught to persons who do not want to learn them and who, if they did want to learn them, could by no possibility turn them to practical account, that it is no matter of astonishment that some persons are disposed to say that "technical education is only the last bit of political humbug, the last new scheme for turning out a brand new society; it is worthless in itself; not only is it worthless, but it is excessively expensive. Well, gentlemen, I am sure Mr. Bryce would agree with everything I have said upon this point, and everything I am going to say upon it, for I shall not go into controversial matter, because, while I think that those who object to technical education have their justification, it yet remains true that if you include, as you ought to include, within the term technical education the really scientific instruction in the way of turning scientific discoveries to practical account, if that is what you mean, and it is what you ought to mean by technical instruction, then there is nothing of which England is at this moment in greater need. There is nothing which, if she, in her folly, determines to neglect it, will more conduce to the success of her rivals in the markets of the world, and to her inevitable abdication of the position of commercial supremacy which she has hitherto held. I do not deny, Mr. President and gentlemen, that if manufactures and commerce have an immense amount to gain from theoretical investigations, and if, as everybody will admit that has even the most cursory acquaintance, let us say, with the history of the discoveries in electricity and magnetism, pure science itself has an enormous amount to gain from industrial development. While both those things are true, I am the last person to deny that it is a poor end, a poor object, for a man of science to look forward to merely to make money for himself or for other people. After all, while the effect of science on the world is almost incalculable, that effect can only be gained in the future, as it has only been gained in the past, by men of science pursuing knowledge for the sake of knowledge, and for the sake of knowledge alone; and if I thought that by anything that had dropped from me to-night I had given ground for the idea that I looked at science from what is commonly called the strictly utilitarian standpoint, that I measured its triumphs by the number of successful companies it had succeeded in starting, or the amount of dividends which it gave to the capitalist, or even by the amount of additional comfort which it gave to the masses of the population, I should greatly understate my thought; but I know this great Society, while it has in view these useful objects, still puts first of all the pursuit of truth, which is the goddess to which every man of science owes his devotion. And truth, not profit, must necessarily be the motto of every body of scientific men who desire to be remembered by posterity for their discoveries. These things can only be done through a disinterested motive, and it is because I believe that societies like the great Society I am addressing do more than any other organisation to attain that great object, because I think they bring together men engaged in congenial pursuits because the stimulus of mind brought close to mind, and the honourable ambitions and the honourable rivalries of men engaged in the same great task, must lead to an enormous extension of our knowledge of the secrets of Nature, that I, as an outsider, not belonging to your body, do, in the name of a public for which I venture to speak, wish you all success and wish you all prosperity.

At the next meeting on Thursday, April 25th, the following papers will be read:—

"The action of nitrosyl chloride on amides." By Professor Tilden, F.R.S., and Dr. M. O. Forster.

"The action of nitrosyl chloride on asparagine and aspartic acid: lævo-rotatory chlorosuccinic acid." By Professor Tilden, F.R.S., and H. J. Marshall.

"On a property of the non-luminous atmospheric coal gas flame." By L. T. Wright.

"A constituent of Persian berries." By A. G. Perkin and J. Geldard.

"Potassium nitrosulphate." By E. Divers, F.R.S., and T. Haga.

"Diortho-substituted benzoic acids." By J. J. Sudborough, Ph.D.

"Hydrolysis of aromatic nitriles and acidamides." By J. J. Sudborough, Ph.D.

"Action of sodium ethylate on deoxybenzoïn." By J. J. Sudborough, Ph.D.

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PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

EDITED BY THE SECRETARIES.

No. 151. Session 1894–95.

April 25th, 1895. Mr. A. G. Vernon Harcourt, President, in the Chair.

Messrs. Francis H. Carr, A. T. Cocking, Alexander Hogg, and Frank Newbolt were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Edgar S. Barralet, 61 Thistlethwaite Road, Clapton, N.E.; Gustav Theodore Bruckmann, B.Sc., 192 18th Street, Brooklyn, N.Y.; Walter W. Cheadle, B.A., 19 Portman Street, W.; Sydney Fawns, 16 Onslow Gardens, S.W.; Alexander F. Fuerst, Ph.D., 30 Belsize Road, N.W.; William Goddard, 11 Granville Road, Middlesbrough; Patrick Hope Grant, 57 S. Guildry Street, Elgin, N.B.; William Abraham Greaves, B.Sc., Bankside, Golden Valley, Alfreton; Charles Butterworth Newton, Gasworks, Rotherham; Frank L. Slocum, Pittsburgh, Pa.; Alfred Stanfield, B.Sc., 21 Markham Square, S.W.; William Thomas Thomson, Austin Villas, Station Road, Waltham Cross; Arthur Thornton, M.A., 67 St. Mary's Terrace, Manningham; William Arthur Whiston, Collegiate School, Llandudno; John Wilson, B.Sc., 11 Cupar Road, Battersea, S.W.

Of the following papers those marked * were read.

*45. "Action of nitrosyl chloride on amides." By William A. Tilden, F.R.S., and M. O. Forster, Ph.D.

The authors find that the interaction of nitrosyl chloride and amides generally results in the exchange of the amidogen group, NH_2, for an atom of chlorine; but, as a molecule of water is formed simultaneously, the chloride produced is converted into the corresponding acid more or less completely according to the conditions of the experiment. Acetamide, benzamide, malonamide, oxamic acid, urea, and urethane behave in this way.

Glycocine and asparagine, as examples of amido-compounds, give the corresponding chloro-acid.

Oxamide is entirely unaffected by nitrosyl chloride at any temperature up to 100°. Oxanilide, hippuric acid, succinimide, and phthalimide are also unattacked.

Since glycocine and asparagine (or aspartic acid) exchange NH_2 for Cl like the amides, the authors regard this as confirming the formulæ by which these substances are represented as amido-derivatives of acetic and succinic acids respectively. They consider the closed chain formulæ, lately revived by Sakurai, to be inadmissible.

*46. "Action of nitrosyl chloride on asparagine and aspartic acid; formation of lævorotatory chlorosuccinic acid." By William A. Tilden, F.R.S., and B. M. C. Marshall.

The authors have studied the products of the action of nitrosyl chloride on asparagine dissolved in hydrochloric acid, and more especially the resultant chlorosuccinic acid. This substance crystallises in short, lustrous prisms, it melts at about 174° with decomposition, and is lævorotatory, $[\alpha]_D = -19{\cdot}67^\circ$, at the temperature of the air. The silver and copper salts may be obtained as precipitates nearly insoluble in water. The acid agrees closely in melting point with the dextrorotatory chlorosuccinic acid obtained from malic acid by Walden, and the values for the specific rotatory power of the two compounds are nearly the same. Walden's acid showed a specific rotatory power of 20·6° to 20·8°. The lower value for the lævorotatory acid is probably due to its partial dissociation into hydrogen chloride and fumaric acid when dissolved in water.

*47. "A property of the non-luminous atmospheric coal-gas flame." By Lewis T. Wright.

The author points out that the separation of the atmospheric gas flame (Bunsen flame) into two distinct parts described by Teclu (*J. pr. Chem.*, **44**, 246) and Smithells and Ingle (Trans., **61**, 204), was discussed by himself in June, 1887, in a paper "On the Induction of the Explosive Wave and an altered Gaseous Condition in an Explosive Gaseous Mixture by a Vibratory Movement," an abstract of which was published in *Roy. Soc. Proc.*, **42**.

The experiments described in that paper were made with a mixture of coal-gas and air in combustion tubing of $\frac{3}{4}$-in. diameter.

The analytical results of that inquiry confirm those obtained by Smithells and Ingle, and bring out a characteristic of the inner flame. It is able to maintain a stationary position in the glass tube against various velocities of egress of the gaseous mixture. The distribution of the oxygen amongst the three principal products of combustion, viz., carbon monoxide, carbon dioxide, and water, differs, however, with the velocity of the gaseous current in the tube. The carbon dioxide increases and the carbon monoxide decreases with increased velocity of the gaseous current.

*48. "Diortho-substituted benzoic acids. I. Substituted benzoyl chlorides." By J. J. Sudborough, Ph.D.

In this paper, the author, after referring to the work of V. Meyer and Sudborough on the esterification of aromatic acids—in which it is shown that diortho-substituted benzoic acids as a rule yield no esters when their alcoholic solutions are saturated with dry hydrogen chloride—describes the preparation and properties of the following substituted benzoyl chlorides. *o*-, *m*-, and *p*-Brombenzoyl chloride; 2·4, 3·5, and 2·6-dibrombenzoyl chloride; 3·4·5 and 2·4·6-tribrombenzoyl chloride; 2·3·4·6-tetrabrombenzoyl chloride; 2·6-dinitrobenzoyl chloride; 2·4·6-trinitrobenzoyl chloride; together with the acid amides and esters obtained from them.

In each case, experiments were made by boiling 0·5 gram of the acid chloride with 20 c.c. of an 8 per cent. solution of pure sodium hydrate. These experiments have shown:—

1. That the acid chlorides which do not contain bromine atoms in the ortho-positions are readily decomposed, in most cases, before the solution begins to boil, in the others within 10 seconds of boiling.

2. That those acid chlorides which are substituted by one bromine atom in an ortho-position are somewhat more stable, and are only completely decomposed after boiling for 2—3 minutes with the alkaline solution.

3. That acid chlorides with bromine atoms in the two ortho-positions are extremely stable.

Thus, while the 2·6-dibrombenzoyl chloride is entirely decomposed after boiling for 35 minutes with the alkaline solution, only 28—30 per cent. of the 2·4·6-tribrom chloride is decomposed after boiling for one hour, and of the tetrabrom chloride from 6 to 8 per cent. is decomposed after boiling for the same length of time with the caustic soda solution.

The decomposition of the di- and tri-nitrobenzoyl chlorides could not be quantitatively followed, as other reactions occur at the same time, and a deep red solution is formed in both cases.

The author intends investigating the corresponding methyl- and chlorbenzoyl chlorides in order to see whether the same rules hold for these as for the brom-derivatives.

*49. "Diortho-substituted benzoic acids. II. Hydrolysis of aromatic nitriles and acid amides." By J. J. Sudborough, Ph.D.

For the preparation of large quantities of substituted benzoic acids from the corresponding nitriles, the author recommends a modified form of the method suggested by Bouveault (*Bull. Soc. Chim.*, [3], 9, 368). Whereas Bouveault states that the method is only applicable to those nitriles which are converted into the acid amides by heating with 90 per cent. sulphuric acid for several hours on the water bath; the author of this paper shows that the method can be used for other nitriles, provided the sulphuric acid mixture is heated on the sand bath to 120—130° for an hour or so. The acid amides thus obtained are converted into the corresponding acids by means of sodium nitrite according to Bouveault's method. The yields are extremely good and it would seem that the method is of very general application. The following acids have been obtained by the method:—

p-brombenzoic acid, 2·4, and 2·6-dibrombenzoic acid, 2·4·6-trichlorbenzoic acid.

The 2·6-dibrombenzoic acid is readily soluble in water and separates out on standing in the form of long needles or short prisms of m. p. 146·5°.

The 2·4, and 2·6-dibrombenzamides, which were obtained as intermediate products in the preparation of the corresponding acids, differ most remarkably in their properties. Thus whilst the 2·4-compound is completely converted into the corresponding acid by heating to 170—180° in a sealed tube with 80 per cent. sulphuric acid, the 2·6-amide under the same conditions is entirely unacted upon.

This behaviour of the two amides is quite analogous to that of the corresponding acid chlorides towards alkalis (see preceding abstract). A study of the work of Claus and his pupils (*J. pr. Chem.*, [2], **37**, 197; *Annalen*, **265**, **266**, **269**, **274**) on the hydrolysis of various substituted aromatic nitriles, shows that the di-ortho-substituted benzamides are, as a rule, remarkably stable towards hydrolysing agents. Thus, while substituted benzonitriles are converted into the corresponding acids by boiling for some time with fairly concentrated sulphuric acid, those nitriles which are substituted in the two ortho-positions yield the acid amides and not the acids under the same treatment. An important exception to this rule appears to be the 2·6-dichlorbenzamide, as Claus and Weil state that the 2·6-dichlorbenzonitrile is directly converted into the acid when heated with sulphuric acid in sealed tubes at 150°. This appears remarkable when compared with the behaviour of the corresponding brom-compounds, and the author hopes to investigate the hydrolysis of various substituted benzamides.

*50. "Note on the action of sodium ethylate on deoxybenzoïn." By J. J. Sudborough, Ph.D.

In attempting to prepare substitution-derivatives of deoxybenzoïn, $C_6H_5{\cdot}CO{\cdot}CH_2{\cdot}C_6H_5$, by heating together deoxybenzoïn, sodium ethylate and various halogen compounds in sealed tubes at 150—160°, the author always observed the production of a considerable quantity of stilbene (diphenylethylene). Experiments have shown that this is produced by the action of sodium ethylate on deoxybenzoïn at 160°, and that a substance which is very soluble in alcohol, and has a much lower m. p., is formed at the same time. On analysis this latter compound proved to be hydroxydibenzyl, $C_6H_5{\cdot}CH(OH){\cdot}CH_2{\cdot}C_6H_5$. It is evidently produced from the deoxybenzoïn by the reducing action of the sodium ethylate. This compound, when heated, loses water, and is converted into stilbene. The hydroxydibenzyl, when recrystallised from hot ligroin (b. p. 40—50°), forms long, silky needles which melt at 63°.

When deoxybenzoïn is heated with sodium methylate, no trace of stilbene is formed. This is interesting when compared with the results obtained by Lobry de Bruyn on the action of sodium ethylate and methylate on various aromatic nitro-compounds.

De Bruyn shows that whilst the methylate acts as a substituting agent, replacing a nitro- by a methoxy-group, the ethylate at the same time acts as a reducing agent, producing more or less of the corresponding azo-compounds.

51. "A constituent of Persian berries." By A. G. Perkin and J. Geldard.

Persian berries, as is well known, contain a glucoside xanthorhamnin (α-rhamnegin) decomposable by acids into isodulate and a colouring matter rhamnetin. With hydriodic acid rhamnetin yields methyl iodide and quercetin, the colouring matter of quercitron bark (Herzig, *Monatsch.*, **9**, 548—561). It is consequently a quercetin monomethylether $C_{16}H_{12}O_7$. According to earlier workers there is also present a second glucoside which gives a colouring matter more soluble in alcohol than rhamnetin. and therefore called β-rhamnetin. Herzig (*Monatsch.*, **10**, 561—567), when studying this subject, isolated from the berries a glucoside which he regarded as a loose double compound of xanthorhamnin and a glucoside of quercetin (quercitrin ?), for by decomposition it gave a mixture of rhamnetin and quercetin. Hence β-rhamnetin appeared to be quercetin.

In this paper it is shown that Persian berries contain a third substance readily isolated from the mixed colouring matters by extraction with toluene. It forms long yellow needles somewhat resembling anthraquinone, melting at 214—215° (quercetin and rhametin both melt above 280°), has the formula $C_{17}H_{14}O_7$, and crystallises from acetic acid with 2 mols. of acetic acid of crystallisation. The triacetyl compound $C_{17}H_{11}O_7(C_2H_3O)_3$, colourless needles, melts at 154—155°, the tribenzoyl compound $C_{17}H_{11}O_7(C_7H_5O)_3$, colourless needles, melts at 204—205°, and the dibromo-compound $C_{17}H_{12}O_7Br_2$, yellow needles, decomposes at 250° before melting. By the action of hydriodic acid it yields quercetin and 2 mols. of methyl iodide, and is therefore a *quercetin dimethyl ether.* Rhamnazin, as we have called this substance, is nearly devoid of dyeing properties. Quercetin being a colouring matter, contains at least two hydroxyls in the ortho position to one another, and in rhamnazin therefore one or two of these hydroxyls must be replaced by a methoxy group, causing this loss of colouring power.

It is known that an aqueous extract of Persian berries ferments at 30—40°, depositing a yellow powder, the supernatant liquid being of an orange-brown colour. This powder is here shown to be a mixture of rhamnetin and rhamnazin with but a trace of quercetin. The supernatant liquid when boiled with acids gives a considerable quantity of quercetin only. It appears therefore that the ferment contained in the berries (Ward and Dunlop, *Annals of Botany*, 1889), while readily decomposing xanthorhamnin and the glucoside of rhamnazin at this temperature, exerts but little influence upon the glucoside of quercetin also present.

The colouring matters of Persian berries are rhamnazin (quercetin dimethyl ether), rhamnetin (quercetin monomethyl ether), and quercetin, $C_{15}H_{10}O_7$, itself.

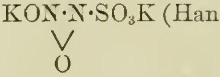
52. "Potassium nitrososulphate." By E. Divers, F.R.S., and T. Haga.

According to Raschig, there are two salts of the composition of Pelouze's potassium nitro(so)sulphate, prepared almost in the same way from nitric oxide and potassium sulphite. Hantzsch has recently (*Ber.*, **27**, 3264) investigated this matter in connection with his studies of the stereoisomerism of nitrogen compounds, and finds that he cannot get the salt like Pelouze's salt, which Raschig got, but only one which is identical with Raschig's other, or second, salt.

There are therefore, it would seem, two isomeric salts, one being Pelouze's salt and the other Hantzsch's. Raschig alone got both these salts.

The authors are convinced that no isomer of Pelouze's salt has been shown to exist. In the first place, Raschig and Hantzsch have confounded the former's first salt with Pelouze's, through supposing that the latter salt is precipitable by dilute solutions of barium salts. In the second place, this first salt prepared by Raschig appears, from his description, to have been so particularly like another obscurely known salt obtained by him, and called "basic potassium dihydroxylaminesulphonate," as to be at present almost indistinguishable from it (as described), whether in composition, in chemical properties, or even in preparation, if only, as might have happened, some nitric peroxide or air got into the sulphite solution along with the nitric oxide. In the third place, a re-examination of Pelouze's salt, in the light of Hantzsch's observations, shows that no sufficient grounds exist for asserting the non-identity of Hantzsch's salt, or the second salt of Raschig's, with Pelouze's salt.

The authors point out that nitrososulphates do not show such near analogy to isonitramines as Traube believes them to do, and regard them as displaying the constitution of a sulphate, $KON_2{\cdot}O{\cdot}SO_3K$, rather than that of a sulphonate, $KON{\cdot}N{\cdot}SO_3K$ (Hantzsch). Potassium nitrososulphate behaves like a sulphonate in giving a barium-potassium salt (and so also does potassium ethyl sulphate, though a true sulphate), but it also gives barium sulphate instantaneously when acidified, and no sulphonate does that.



$$\underset{\displaystyle\vee\atop O}{KON{\cdot}N}{\cdot}SO_3K$$

53. "The milk of the Gamoose." Second notice.

By H. Droop Richmond.

In a previous paper (Trans., **57**, 758) the author described a sugar existing in the milk of the gamoose, differing in its properties from milk sugar. He now finds that this sugar is not always present in the milk of these animals, and describes experiments showing the difference between milk examined in January, 1890, and August, 1891.

May 2nd, 1895. Mr. A. G. Vernon Harcourt, President,
in the Chair.

Messrs. Vaughan Cornish, G. Cecil Jones, and Patrick H. Kirkaldy were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. James Morison, 7, O'Connell Street, Sydney, N.S.W., Albert Joseph Simons, Elmhurst, New Barnet.

Of the following papers those marked * were read:—

***54. "Studies on the constitution of the tri-derivatives of naphthalene. No. 10. The dichloro-α-naphthols and trichloronaphthalenes from 3 : 4-dichlorophenyl-1-isocrotonic acid." By Henry E. Armstrong, F.R.S., and W. P. Wynne, D.Sc.**

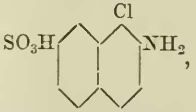
Having increased the number of known trichloronaphthalenes to 13 and determined their constitution (*cf.* these Proceedings, 1889, 48; 1890, 11, 84, 125 *et seq.;* 1891, 27; B.A. Report, 1891, 265), the authors naturally endeavoured to obtain the only remaining member of the series—the 1 : 2 : 1′-trichloronaphthalene; and failing to prepare this by any of the ordinary methods, they turned their attention in the autumn of 1890 to the two dichloronaphthols described by Erdmann and Schwechten (*Annalen*, **260**, 78; *cf.* **275**, 286), one of which was necessarily the 1 : 2 : 1′-, and the other the 2 : 3 : 1′-derivative, as both were formed on distilling 3 : 4-dichlorophenyl-1-isocrotonic acid. But as their discoverers had not ascertained the exact constitution of either, it was necessary to examine both; and through the courtesy of Dr. Erdmann, the authors were enabled to undertake their investigation: they ultimately succeeded in preparing the desired trichloronaphthalene from the dichloronaphthol of lower melting point. Special care was taken to purify the materials used (*cf.* Wynne, Trans. C.S., 1892, 1053), as no other case was known of two isomeric chloronaphthols being simultaneously formed on condensing a chlorophenylisocrotonic acid. The purified dichlorophenylparaconic acid melting at 138° obtained from 1700 grams of 1 : 3 : 4-dichlorotoluene weighed 326 grams; on converting it into the isocrotonic acid and distilling this acid, the two isomeric dichloro-α-naphthols were obtained in the proportion of about one part of that of the lower to two parts of that of the higher melting point.

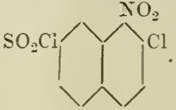
1 : 2 : 1′-dichloro-α-naphthol crystallises from dilute alcohol in slender, flat needles, 2—3 mm. long; it melts at 95° (not 83°, as stated by Erdmann and Schwechten). Its acetate crystallises in long, flat

needles, melting at 87—88° (not 71—72°). On distillation with phosphorus pentachloride, it yields a mixture of tri- with some tetra-chloronaphthalene, separable by crystallisation from methylic alcohol. The trichloronaphthalene thus obtained crystallises in long, slender needles melting at 83°; its identity with the 1 : 2 : 1′-compound prepared by Cleve's method has been established by a careful comparison, by optical methods, of the two products.

2 : 3 :1′-dichloro-α-naphthol melts at 151°, and has all the properties ascribed to it by its discoverers; on distillation with phosphorus pentachloride, it also yields a mixture of tri- and tetra-chloronaphthalene, from which the former can be separated by fractional crystallisation from methylic alcohol. The trichloronaphthalene crystallises in microscopic needles melting at 109°, and has been identified by optical methods with the 2 : 3 : 1′-derivative of this melting point first described by the authors in 1890 (Proc., 1890, 83).

*55. "Studies on the constitution of the tri-derivatives of naphthalene. No. 11. The trichloronaphthalene derivable from Cleve's 1 : 2 : 2′-α-nitrochloronaphthalenesulphonic chloride." By Henry E. Armstrong, F.R.S., and W. P. Wynne, D.Sc.

Of the three isomeric chloro-β-naphthylaminesulphonic acids described by the authors in their papers on the determination of the constitution of the heteronucleal di-derivatives of naphthalene (these Proceedings, 1889, 34 and 48), one (the so-called No. 3 acid) was shown to have the constitution , and from this a dichloronaphthalenesulphonic chloride melting at 122—123°, and a trichloronaphthalene melting at 83—84°, were prepared, which presumably were also 1 : 2 : 2′-derivatives.

The important series of experiments on the nitration of the chloronaphthalenesulphonic chlorides carried out by Cleve in 1892–93, includes the nitration of the 2 : 2′-derivative (*Ber.*, 1892, 2485; *Öfversigt*, &c., 1892, 417), from which he prepared a nitrochlorosulphonic chloride of the formula . Although he obtained a dichloronaphthalenesulphonic chloride from this nitro-compound identical with that prepared by the authors from their No. 3 acid, yet by directly distilling the nitrosulphonic chloride with phosphorus pentachloride Cleve obtained a product which he described as a trichloronaphthalene, which separated from alcohol in crystalline granules *melting at* 75·5°, and it was stated by him that this was identical with that prepared by Alén from α-nitronaphthalene-2 : 2′-disulphonic chloride (see further). And in describing his method of preparing 1 : 2 : 1′-trichloronaphthalene shortly afterwards (*Öfversigt*, 1893, 81), Cleve regarded the substance he obtained as identical with that prepared by the authors from their No. 3 acid; he does not appear to have made any direct comparison of the products from the two sources, however.

Comparing these observations together, as in the following table, it is evident that either a remarkable isomeric change occurs when a disulphonic chloride, but not when a nitrosulphonic chloride, is distilled with phosphorus pentachloride, or Cleve's conclusions are erroneous.

	$Cl_2{\cdot}SO_2Cl$.	$Cl_2{\cdot}SO_2NH_2$.	Cl_3.
From No. 3 acid	122–123°	225—226°	83—84°*
„ Cleve's 1 : 2 : 2′ $NO_2{\cdot}Cl{\cdot}SO_2Cl$.....	124°	227°	75·5°†
„ „ 1 : 2 : 1′ „	138°	221° or 226°	83°*

* From $Cl_2{\cdot}SO_2Cl$ by distillation with PCl_5.
† „ $NO_2{\cdot}Cl{\cdot}SO_2Cl$ by distillation with PCl_5.

A repetition of the author's work with the No. 3 acid on a large scale shows that, when pure, 1 : 2 : 2′-trichloronaphthalene has two melting points, 88° and 84°. The higher melting point is observed when the substance is first fused; but if it be allowed to solidify and then remelted, the melting point is found to be 84°, and usually does not vary from this until a crystal of the original substance is added to the fused mass between 60° and 80°.

On repeating Cleve's investigation of the 1 : 2 : 2′-nitrochloronaphthalenesulphonic chloride, it is found that not only does the trichloronaphthalene obtained from this substance—by converting it into the dichlorosulphonic chloride and distilling this with phosphorus pentachloride—melt at 88° and 84°, as above described, but that even Cleve's own method—distillation of the nitro-derivative with phosphorus pentachloride—also leads to a like result: thus, on once crystallising from alcohol 39 grams of the product prepared by this method, a first separation of no less than 28 grams was obtained which had the double melting point 88° and 84°, whilst, of the remainder, 5 grams more were eventually obtained pure by fractional crystallisation, 3 grams melting at 75—76°, and the remainder at intermediate temperatures.

In fine, the 1 : 2 : 2′-trichloronaphthalene prepared either by Cleve's or the authors' method, melts at 88° or 84°, and not at 75·5°. That the two are identical is also shown by the fact that both yield similar derivatives, notably a monosulphonic acid affording a potassium salt, $C_{10}H_4Cl_3 \cdot SO_3K + H_2O$, which crystallises in sparingly soluble flat needles, and a *chloride* which is sparingly soluble in benzene and crystallises in small rhombs melting at 173°. That Cleve is in error in regarding the trichloronaphthalene from the authors' No. 3 acid as the 1 : 2 : 1′-derivative is further shown by the fact that the monosulphonic acid prepared from this latter modification affords an anhydrous potassium salt crystallising in flat needles, and a *chloride* crystallising in prismatic needles melting at 105°.

*56. "Studies on the constitution of the tri-derivatives of naphthalene, No. 12. The trichloronaphthalene derivable from Alén's α-nitronaphthalene-2 : 2′-disulphonic chloride." By Henry E. Armstrong, F.R.S., and W. P. Wynne, D.Sc.

By nitrating 2 : 2′-naphthalenedisulphonic chloride. Alén obtained a nitro-derivative, from which, by distillation with phosphorus pentachloride, a compound was formed which melted at 75·5°, and was regarded by him as a trichloronaphthalene (*Öfversigt*, 1884, 97). This compound, the [θ-]derivative, was regarded by the authors as impure 1 : 3 : 3′-trichloronaphthalene (*cf. B.A. Report*, 1891, 265), and not investigated until Cleve announced its supposed identity with the product obtained from the 1 . 2 . 2′-α-nitrochloronaphthalenesulphonic chloride. A repetition of Alén's work has established the correctness of the authors' view as against that of Cleve.

The 1 : 2 : 2′-α-chloro-β-naphthylaminesulphonic acid (No. 3 acid) can be converted into the *xanthate* $EtO \cdot CS \cdot S \cdot C_{10}H_5Cl \cdot SO_3K + H_2O$, which crystallises in minute prisms, and this into the sparingly soluble *sulphide-sulphonate*, $[S \cdot C_{10}H_5Cl \cdot SO_3K]_2 + \frac{1}{2}H_2O$—by Leuckart's method (*J. pr. Chem.*, [2], **41**, 218)—from which the 1 . 2 . 2′-α-chloronaphthalenedisulphonic acid is obtained by oxidation with permanganate solution (*cf.* Proc., 1893, 166).

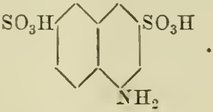
On hydrolysing the Alén nitrodisulphonic chloride melting at 138° with aqueous caustic potash, a *potassium* salt (containing $3H_2O$) is obtained, which by reduction with ferrous sulphate and caustic potash is converted into the very soluble salt of the amido-acid. The *acid potassium* salt ($+ 3H_2O$) crystallises in slender, readily soluble needles, and is convertible, by Sandmeyer's method, into an α-chloronaphthalenedisulphonic acid isomeric with that obtained from the No. 3 acid, as is evident from the table.

	From No. 3 acid, by xanthate method.	From Alén's nitro-acid.
$Cl{\cdot}C_{10}H_5(SO_3K_2)$	$\frac{1}{3}H_2O$	$2H_2O$
$Cl{\cdot}C_{10}H_5(SO_2Cl)_2$	prisms, m. p. 144°	dimorphous— prisms, m. p. 114°. needles, m. p. 127°.
$C_{10}H_5Cl_3$	m. p. 88° and 84°	80·5°

When prepared by distilling the corresponding chlorodisulphonic chloride with phosphorus pentachloride, the trichloronaphthalene from the Alén acid melts at 80·5° after once crystallising it, and even when prepared by Alén's method, *i.e.*, by distilling the nitrodisulphonic chloride with phosphorus pentachloride, melts at a higher temperature than 75·5° after it has been once crystallised; thus, 9 grams of product from this source gave on the first crystallisation 6 grams melting at 78—79°, from which 5 grams melting at 80·5° were eventually obtained, whilst of the residue some melted at 75—76° and some as low as 65—68°. That the trichloronaphthalene melting at 80·5° obtained by either method is identical with the 1 : 3 : 3′-derivative of this melting point (Proc., 1890, 129; 1891, 27) is clearly shown by the behaviour on sulphonation, as they all yield a monosulphonic acid affording a monohydrated potassium salt crystallising in long, slender needles, and a *chloride* crystallising from benzene in radiate groups of long needles melting at 154°.

*57. "Studies on the constitution of the tri-derivatives of naphthalene, No. 13. The α-naphthylamine-2 : 2′-disulphonic acid of Freund's German Patent 27346." By Henry E. Armstrong, F.R.S., and W. P. Wynne, D.Sc.

Through the kindness of Messrs. Cassella and Co., the authors were furnished with a supply of the acid sodium salt of the α-naphthylamine-2 : 2′-disulphonic acid which had been isolated from the mixed product obtained by working under the conditions of Freund's German Patent 27346. The acid sodium salt, $NH_2{\cdot}C_{10}H_5(SO_3H){\cdot}SO_3Na + 3H_2O$, crystallises in tufts in long, slender needles, easily soluble in hot water. By the hydrazine method it is converted into naphthalene-2 : 2′-disulphonic acid (characterised by conversion into the chloride crystallising from benzene in prisms melting at 157°, and into 2 : 2′-dichloronaphthalene melting at 114°). On treatment by the Sandmeyer process it gave a chlorodisulphonic acid, the *chloride*, $Cl{\cdot}C_{10}H_5(SO_2Cl)_2$, of which crystallised from a mixture of benzene and petroleum spirit in two forms, being dimorphous, namely, in clusters of small prisms melting at 114°, and in needles melting at 127°. After solidifying in the melting-point tube, the chloride melted constantly at 127°, although the lower melting point, 114°, could again be obtained by adding to the fused substance at about 100° a crystal of this form. On distillation with phosphorus pentachloride, the chloride was converted into 1 : 3 : 3′-trichloronaphthalene melting at 80·5° which was characterised in the usual way by sulphonation. These results make it evident that the constitution of the acid is identical with that of the Alén acid just described, and that both are represented by the formula



*58. "The non-existence of a trichloronaphthalene melting at 75·5°. The formation of chloro-derivatives from sulphonic chlorides." By Henry E. Armstrong, F.R.S., and W. P. Wynne, D.Sc.

From the foregoing it is evident that the "trichloronaphthalene" melting at 75·5°, described by Alén, was impure 1 : 3 : 3′-trichloronaphthalene, and that of Cleve impure 1 : 2 : 2′-trichloronaphthalene. The impurity was in all probability tetrachloronaphthalene, as Cleve's analysis (found 46·66 per cent. Cl, against 45·98 per cent.), and analyses of material of similar melting point obtained by the authors by Cleve's method (found 46·52 per cent. Cl) and by Alén's (found 46·48 per cent. Cl), give numbers too high for a trichloronaphthalene. The quantity of material obtained from each of these two sources has been insufficient to admit of more than the pure trichloronaphthalene being isolated from the sulphonation product of each. The cause of the formation of tetrachloronaphthalene is probably to be sought in the fact that when phosphorus pentachloride is used to displace the NO_2 radicle in nitro-compounds, or the OH radicle in naphthols, its action is entirely different in character from that which is exercised in the case of sulphonic chlorides. In the case of the former, substitution occurs, and higher chlorination products are almost invariably formed; in that of the latter (*cf. B.A. Report*, 1894, 268) the halogen derivative seems to be formed by the elimination of the SO_2 of the SO_2Cl radicle, not by a displacement of the radicle by chlorine derived from the pentachloride. The presence of the pentachloride seems to assist this elimination, and to increase the yield of product, but in most cases is not necessary for the action to pursue its course; and in certain instances it is advantageous that the chloride should be heated alone. Thus when 1 : 1′-chloronaphthalenesulphonic chloride—which is known to be remarkable for the readiness with which it gives 1 : 4 : 1′-trichloronaphthalene on distillation with phosphorus pentachloride—is heated at a temperature rising from 200° to 230° during three hours so long as SO_2 is evolved, a large quantity of 1 : 1′-dichloronaphthalene (m. p. 88°) is obtained, together with small quantities of α-monochloro- and a trichloronaphthalene; 1 . 2-α-chloronaphthaleaesulphonic chloride is exceptional in affording a condensation product when heated without pentachloride, hydrogen chloride being constantly evolved, and only traces of 1 : 2-dichloronaphthalene being formed; but the other isomeric chloronaphthalenesulphonic chlorides behave, so far as examined, like the isomeric 2 : 4′-derivatives, thus

	2:4′ $\beta Cl \cdot SO_2Cl$ with PCl_5.	2:4′ $\beta Cl \cdot SO_2Cl$ without PCl_5.	1:3′ $\alpha Cl \cdot SO_2Cl$ with PCl_5.	1:3′ $\alpha Cl \cdot SO_2Cl$ without PCl_5.
Temp. of action	190°	210—230°	195°	230—250°.
Yield of 2 : 4′ Cl_2	92 per cent.	62 per cent.	65 per cent.	39 per cent.

The influence of the β- as compared with the α-position of the SO_2Cl radicle on the yield by both methods is evident from these data.

It may be pointed out that not only are all doubts as to the validity of the method of determining constitution by converting sulphonic chlorides into chloro-derivatives by distillation with phosphorus pentachloride set at rest by the agreement of the results obtained with and without pentachloride, but that independent and most important confirmation of the correctness of the conclusions arrived at is afforded by the fact that the same ultimate product by directly displacing NH_2 in an amido-compound of chlorine by the Sandmeyer-Griess method and indirectly displacing it by chlorine by first preparing the xanthate, then oxidising to sulphonic acid, and distilling the chloride of this acid alone or with pentachloride. Moreover, the general agreement of the authors' results is such that they believe they are justified in regarding their conclusions as final.

*59. "Studies on the constitution of the tri-derivatives of naphthalene, No. 14. The fourteen isomeric trichloronaphthalenes." By Henry E. Armstrong, F.R.S., and W. P. Wynne, D.Sc.

The thirteen isomeric trichloronaphthalenes considered in connection with methods leading to the elucidation of their constitution in the authors' previous papers (*cf.* these Proceedings, 1889—1890), have not as yet been tabulated by them with their melting points, it

Trichloronaphthalenes.

State of knowledge at the end of 1888.	Constitution and melting points assigned by				
	Armstrong and Wynne, 1889-90.		Cleve, 1892–93.	Armstrong and Wynne, 1895.	
[α-] 1 : 2 : 3. M. p. 81° (Widman)	1 : 2 : 3	81°	—	81°	[2]*
1 : 2 : 4. ,, 92° (Cleve)	1 : 2 : 4	92°	—	92°	[1]
—	1 : 2 : 4′ (1 : 2 : 5)	78·5°	77°; 76°	78·5°	[5]
? : 2 : 6. ,, 91° (Forsling)	1 : 2 : 3′ (1 : 2 : 6)	92·5°	90°	92·5°	[4]
—	1 : 2 : 2′ (1 : 2 : 7)	83—84°	75·5°	88° and 84°	[3]
—	1 : 2 : 1′ (1 : 2 : 8)	—	83°	83·5°	[2]
[γ-] 1 : 3 : ? ,, 103° (Widman)	1 : 3 : 4′ (1 : 3 : 5)	103°	103°	103°	[5]
[θ-] α : 2 : 7. ,, 75·5° (Alén)	1 : 3 : 3′ (1 : 3 : 6)	80·5°	—	80·5°	[6]
[η-] α : 2 : 6. ,, 113° (Alén)	1 : 3 : 2 (1 : 3 : 7)	113°	—	113°	[7]
[β-] 1 : ? : ? ,, 90° (Atterberg)	1 : 3 : 1′ (1 : 3 : 8)	87° and 90°	—	89·5° and 85°	[2]
[δ-] 1 : 4 : 5. ,, 131° (Atterberg)	1 : 4 : 4′ (1 : 4 : 5)	131°	130°	131°	[4]
[ε-] 2 : ? : ? ,, 65° (Cleve) [ζ-] 2 : ? : β ,, 56° (Widman)	1 : 4 : 3′ (1 : 4 : 6)	66° and 56°	65° and 56°	66° and 56°	[6]
—	2 : 3 : 4′ (2 : 3 : 5)	109·5°	—	109°	[2]
—	2 : 3 : 3′ (2 : 3 : 6	91°	—	91°	[4]

* Number of methods, each involving a determination of the relative positions of at least one pair of radicles, by which the compound has been prepared.

being deemed desirable to set all doubts at rest before doing this. Since 1890 they have entirely revised their earlier work and extended it, in order to obtain the various trichloronaphthalenes in quantities of from 35 to 50 grams; additional methods of preparation have also been devised with the object of accumulating evidence from as many sources as possible capable of throwing light on the relative positions of any pair of radicles in the tri-derivatives. As a result, the trichloronaphthalenes have not only been characterised by conversion into monosulphonic acids, but their constitution has been determined by so many methods that there is now no room for doubt that the fourteen predicted by theory are known, and that they have the melting points assigned to them in the following table. The number of methods of preparation, each involving the determination of the relative positions of at least one pair of radicles, is given in brackets in the last column. Details regarding the properties of the trichloronaphthalenes, especially of their sulphonic derivatives, are reserved for the complete publication, as these have no bearing on the general questions considered in these notes.

*60. "The solubilities of gases in water under varying pressure."

By E. P. Perman, D.Sc.

The method used may be briefly described as follows:—A rapid current of air is aspirated through a saturated solution of the gas, the solubility of which is to be determined, and the amounts of the gas drawn off in given intervals of time, as well as the amount left in solution at the end of the experiment, are estimated, usually by a volumetric method. A curve is then drawn by plotting the amounts of gas (in grams) in solution against the time (in minutes) during which the aspiration has been carried on. A series of tangents to this curve are then drawn; their values give the *rates* at which the gas is drawn off at different concentrations, and these *rates* are measures of the pressure of the gas in solution. The rates were then plotted against the corresponding concentrations. If the rate is proportional to the concentration, the pressure of the gas is also proportional to the concentration, and the law of Henry holds good for the gas in question.

The aspiration was carried on in a series of five wash-bottles; the first to contain water, which makes up for loss by evaporation of the solution in the second; the second to contain the solution of the gas the other three to contain water or some solution to absorb the gas drawn off. Air was drawn through the series of flasks by means of a water air-pump, and a regulator was placed between the pump and the flasks.

Experiments were made with solutions of ammonia, chlorine, bromine, carbon dioxide, hydrochloric acid gas, sulphuretted hydrogen, and sulphur dioxide. Henry's law was found to hold good for chlorine, bromine, carbon dioxide, and sulphuretted hydrogen, while ammonia, hydrochloric acid gas and sulphur dioxide showed large deviations which appear to be caused by the formation of compounds of these gases with water.

DISCUSSION.

In reply to questions from the PRESIDENT and Professor ARMSTRONG as to whether the air drawn through the solution of the gas becomes saturated, Dr. PERMAN stated that the air does not take up as much gas as it would if the current were extremely slow, and is therefore probably not saturated in this sense. He considered, however, that this fact does not invalidate the method. The amount of gas taken up by the air in a small interval of time will be proportional to the pressure of the gas in solution, just as the amount of aqueous vapour given up by a pan of water placed in a steady current of air would be proportional to the vapour-pressure of the water. The only necessary assumption is that the gases are "perfect," as they may certainly be taken to be for the purposes of the experiment.

*61. "The existence of hydrates and of double-compounds in solution. Part I." By E. P. Perman, D.Sc.

The effect upon the pressure of ammonia gas in an aqueous solution produced by dissolving various salts in the gaseous solution was investigated by the method described in the preceding paper.

The gas-pressure was unaltered by dissolving 3·9 grams sodium chloride in 50 c.c. of ammonia solution containing 4·43 grams of ammonia.

The pressure was also unaltered when 11·23 grams of sodium sulphate, $Na_2SO_4\cdot 10H_2O$, were dissolved in 50 c.c. of the ammonia solution; but on dissolving 3·8 grams of the anhydrous sulphate in the same quantity of solution, the gas-pressure was increased considerably, and the increase of pressure corresponded exactly to the increase of concentration which would be caused by a loss of 4·8 grams of water, *i.e.* $10H_2O$ for every next drop of sodium sulphate. The author regards this as conclusive evidence that the sodium sulphate exists in solution as a definite hydrate, $Na_2SO_4\cdot 10H_2O$.

Silver chloride at once reduced the pressure of the ammonia when introduced into the solution, thus showing that some compound of silver chloride and ammonia was formed.

In a solution containing 4 grams of ammonia, and saturated with silver chloride, the pressure was the same as in an ammonia solution containing 2·8 grams of ammonia in the same bulk (50 c.c.); 1·2 grams had therefore entered into combination with the silver chloride, ·0235 gram molecules (from Bodländer's table of solubilities of silver chloride in ammonia solution). This corresponds to a compound $AgCl·3NH_3$. The existence of the same compound is also indicated in more dilute solutions.

62. "Derivatives of π-bromocamphoric acid." By F. Stanley Kipping, Ph.D., D.Sc.

The syrupy acid obtained on treating π-bromocamphoric acid with alcoholic potash (Proc., 1895, **148**, 33) has now been obtained in a crystalline condition and further analysis has confirmed the view that it is a hydroxycamphoric acid of the composition $C_{10}H_{16}O_5$. (Found C = 55·1, H = 7·4; theory C = 55·5, H = 7·4 per cent.).

When π-bromocamphoric acid is warmed with aqueous potash it is first converted into an acid which is very readily soluble in water, and which is probably the hydroxy-acid just mentioned; on continued treatment, however, this initial product is transformed into a more sparingly soluble, well-defined acid of the composition $C_{10}H_{14}O_4$. (Found C = 60·4, H = 7·1; theory C = 60·6, H = 7·1 per cent.). This compound separates from water and dilute alcohol in large fern-like forms which seem to contain water of crystallisation, but it is deposited from a mixture of chloroform and benzene in transparent anhydrous crystals melting at about 165°; apparently it is a saturated compound as its solution in sodium carbonate does not decolorise potassium permanganate at ordinary temperatures.

An isomeride of this acid is formed in small quantities, together with other products, when π-bromocamphoric acid is heated with quinoline under suitable conditions. (Found C = 60·5, H = 7·1; theory C = 60·6, H = 7·1 per cent.); this compound crystallises from water and dilute alcohol, in which it is rather sparingly soluble, in beautiful stellate forms and in six-sided plates, and melts at about 226°; it sublimes unchanged, does not give an anhydride when warmed for some time with acetic chloride, and its solution in sodium carbonate does not decolorise potassium permanganate even on boiling for a short time: these properties seem to show that it is a saturated lactonic acid.

The acid melting at about 165° is readily oxidised by warm, very dilute nitric acid, the final product being a crystalline acid, which seems to have the composition $C_{10}H_{14}O_6$. (Found C = 52·0, H = 6·1; theory C = 52·2, H = 6·1 per cent.); this substance is very readily soluble in water from which it is deposited in six-sided plates which seem to contain water of crystallisation; it crystallises from ethereal chloroform in lustrous prisms, melting at about 195°. When heated with acetic chloride for a short time this acid is converted into a substance which crystallises in beautiful six-sided prisms, melting at about 250°; this product dissolves in sodium carbonate with effervescence and is probably an anhydride acid of the composition $C_{10}H_{12}O_5$, but an analysis has not yet been made.

The results indicated above afford additional facts on which to base a constitutional formula for camphoric acid, but their theoretical import cannot be discussed here.

63. "Paraheptyltoluene and its derivatives." By F. Stanley Kipping, Ph.D., D.Sc., and O. F. Russell.

This paper contains an account of *p*-heptyltoluene, $C_6H_{13}\cdot CO\cdot C_6H_4Me$, and of various other compounds which have been referred to in previous notes (Kipping, Proc., 1893–94, **128**, 208, and **136**, 60).

64. "Note on the formation of a phosphate of platinum." By Robert E. Barnett.

On subliming commercial phosphorus pentoxide over red hot spongy platinum in a current of oxygen, part of the platinum is converted into a yellow substance, which being insoluble in aqua regia can thus be separated from the excess of the metal.

The analysis agrees with the formula, PtP_2O_7. It is a greenish-yellow powder of rel. dens. 4·856, and is stable at a red heat unless reducing gases are present. It is insoluble in water, acids, and aqueous alkalies, but is decomposed by fusion with potassium sodium carbonate. Aqueous hydrogen sulphide slowly decomposes the compound; the exact nature of the products is still being investigated.

ADDITIONS TO THE LIBRARY.

I. *Donations.*

Artificial Manures. How to make, buy, value and use. A Handbook for agriculturists, chemical manure manufacturers, gardeners, and others concerned in similar pursuits. By Alfred Sibson, F.C.S. New Edition revised and rewritten by the Author and A. E. Sibson, F.C.S. Pp. x+140. London 1895. From the Author.

Californian State Mining Bureau. Twelfth Report of the State Mineralogist (Second Biennial). Two years ending September 15, 1894. 8vo. Pp. vi+541. Sacramento 1894. From the Bureau.

Californian State Mining Bureau. The Gas- and Petroleum-yielding Formations of the Central Valley of California. By W. L. Watts, M.E., Assistant in the Field. 8vo. Pp. 100. Sacramento 1894. From the Bureau.

Bibliography of Aceto Acetic Ester. By Paul H. Seymour, M.S. City of Washington, published by the Smithsonian Institution, November, 1894. 8vo. Pp. x + 148. From Smithsonian Miscellaneous Collections, Vol. XXXVIII (No. 970).
From the Institution.

II. *By Purchase.*

Introduction à la Mécanique Chimique. Par P. Duhem. 8vo. Pp. vii + 178. Paris 1893.

Grundzüge der mathematischen Chemie. Energetik der Chemischen erscheinungen. Von Dr. Georg Helm. Mit 17 figures in text. 8vo. Pp. vi + 138. Leipzig 1894.

Handbuch der Stereochemie. Unter Mitwirkung von Dr. Paul Walden, Professor der Physikalischen und Analytischen Chemie am Polytechnikum zu Riga. Herausgegeben von Dr. C. A. Bischoff, Professor der allgemeinen Chemie daselbst. Mit 250 Abbildungen im Text und den Bildnissen von L. Pasteur, Le Bel, und J. van't Hoff. Frankfurt a. M. Verlag von H. Bechold, 1894. 8vo. Vol. II. Pp. xvi, 449—1060.

Theoretical Chemistry from the Standpoint of Avogadro's Rule and Thermodynamics. By Prof. Walter Nernst, Ph.D. (University of Gottingen). Translated by Prof. Charles Skeele Palmer, Ph.D. (University of Colorado). With 26 woodcuts and two appendices. 8vo. Pp. xvi + 697. London 1895.

ERRATUM.—No. 150, page 45, line 2, *for* "heated," *read* "treated."

At the next meeting, on Thursday, May 16th, there will be a ballot for the election of Fellows, and the following papers will be read :—

"Kjeldahl's Process for the determination of Nitrogen." By Dr. Bernard Dyer.

"The action of nitrous acid on 1 : 4 : 2 dibromaniline." By Professor Meldola, F.R.S., and E. R. Andrews.

"Derivatives of succinyl and phthalyl dithiocarbimides." By Professor Dixon and Dr. Doran.

CERTIFICATES OF CANDIDATES FOR ELECTION AT THE NEXT BALLOT.

N.B.—The names of those who sign from "General Knowledge" are printed in *italics.*

The following Candidates will be balloted for on Thursday, May 16th, 1895:—

Anden, Harold Allden,

102, Acomb Street, Manchester.

Research Student in the Owens College. Three years Student in Owens College Laboratories. B.Sc., with Honours in Chemistry, 1894. Now engaged in research.

Harold B. Dixon. W. H. Perkin, jun.
Arthur Harden. P. J. Hartog.
Gilbert J. Fowler. G. H. Bailey.

Barralet, Edgar S.,

61, Thistlewaite Road, Clapton, N.E.

Chemist for Messrs. Wm. Burton and Sons, Bethnal Green, London, N.E. Has studied Chemistry specially for three years at the Drapers' Company's Technical Schools, Mile End, E. Passed S. and A. Department examinations in Organic and Inorganic Chemistry in the Honours stage. Is now engaged on research in reference to Coal Tar colours.

J. Theo. Hewitt. D. S. Macnair.
A. P. Laurie. R. Tervet.
S. Ruhemann. *M. M. Pattison Muir.*
Boverton Redwood.

Blume, Eugen,

Russell House, Trinity, Edinburgh.

Assistant to Public Analyst. For four years Assistant to Mr. J. Falconer King, City Analyst, &c., during which time I demonstrated for one year at his lectures on General Chemistry. During the last two years I have given lectures and prepared students privately myself in Chemistry.

J. Falconer King.
John W. Napier.
W. Ivison Macadam.
Stevenson Macadam.
Robert Irvine.
Robert Wallace.
J. Gibson.

Borradaile, Lancelot Alexander,
Selwyn College, Cambridge.

Assistant to the Science Tutor, Selwyn College, Cambridge, and Assistant Demonstrator in Biology at Univ. Lab. 1st Class, Pt. I, Nat. Sci. Tripos, 1893. 1st Class, Pt. II, Nat. Sci. Tripos, 1894.

Charles T. Heycock.
Albert Ivatt.
Sidney Skinner.
G. D. Liveing.
F. H. Neville.

Bradford, Henry,
21, Kensington Mansions, Earl's Court, S.W.

Analytical Chemist. For three years pupil of E. G. Clayton, F.C.S., Consulting Chemist and Public Analyst. Has attended lectures on Organic Chemistry by J. N. Collie, Ph.D., and on Chemical Technology, by Watron Smith, F.C.S., at University College, W.C. Has also worked for some months in the laboratory of the E. C. Powder Company, Ld., near Dartford, under W. Dalrymple Borland, F.C.S.

E. G. Clayton.
Watson Smith.
John A. R. Newlands.
J. Parry Laws.
W. Dalrymple Borland.
Geo. Chaloner.
Wm. P. R. Newlands.
Chapman Jones.

Bruckmann, Gustav Theodore,
192, 18th Street, Brooklyn, N.Y.

Chemist and Chemical Engineer. Bachelor of Science. Graduate Rensselaer Polytechnic Institute; in soda industry with Grasselli Chem. Co., N.Y. and Cleveland; in colour industry with Cawley, Clark, and Co., Newark, N.J. At present with National Lead Co., N.Y., as Chemist.

Alfred Hy. Mason.
T. Lynton Briggs.
S. W. Williams.
R. C. Woodcock.
E. G. Love.
Joseph P. Remington.
Chas. M. Stillwell.

Cheadle, Walter W., B.A. (Cambridge),
19, Portman Street, London, W.

Natural Science Tripos, Cambridge, 2nd Class. Late Demonstrator in Chemistry at Westminster School. Course of Brewing Chemistry with Drs. Moritz and Morris.

E. R. Moritz.	Arthur P. Luff.
G. Harris Morris.	Horace T. Brown.
J. H. Millar.	

Coblentz, Virgil, Ph.G., A.M., Ph.D.,

115, W. 68th Street, New York City.

Professor of Pharmacy and Pharmaceutical Chemistry in the New York College of Pharmacy, N.Y. Formerly Lecturer in Cincinnati College of Pharmacy. Studied Chemistry in Goettingen, Strassburg, and Berlin (Ph.D.). Author of "Handbook of Pharmacy," "Modern Synthetic Remedies," "Sulfur and Selenium Derivatives of Ethylamine and Propylamine," "Chemistry of Cocillana," "Study of Aconitum Unciatum," &c.

Alfred Hy. Mason.	Arthur H. Elliott.
Charles F. Chandler.	Sam. P. Sadtler.
R. C. Woodcock.	*E. G. Love.*
S. W. Williams.	*John Attfield.*

Cook, Herbert William,

West Mount, Upton, Macclesfield.

Lecturer and Teacher. Lecturer in Chemistry to the Technical Instruction Committee, Macclesfield. Science Master in King Edward VI. School, Macclesfield. B.Sc. (London University).

Chas. Umney.	G. Carey Foster.
Samuel Rideal.	J. W. Rodger.
Chapman Jones.	*A. E. Tutton.*

Druce, Edric,

Worleston, Nantwich.

Agricultural Lecturer to the Cheshire County Council. Teacher for two years of General and Agricultural Chemistry at the Cheshire Dairy Institute. Experimented upon Acidity in Milk. Carried out Experiments on the effect of Foods on Milk. Member of the Royal Agricultural College, by examination.

Edward Kinch.	James Hendrick.
James Muir.	A. G. Bloxam.
Cecil C. Duncan.	*J. Augustus Voelcker.*

Fawns, Sydney,

16, Onslow Gardens, S.W. (Melbourne, Victoria).

Metallurgist (speciality, Gold Saving). At present engaged in Analytical Work, Royal College of Science. Reasons for desiring admission:—To obtain the Society's Journal and attend the meetings, and so keep in touch with the latest chemical discoveries. Associate of the Australian Institute of Mining Engineers.

William A. Tilden. W. Palmer Wynne.
Chapman Jones. A. E. Tutton.
William Tate.

Foster, Hasslewood Irving,

The Elms, Aulaby Road, Hull.

Analytical Chemist (in practice). Two years Assistant with Mr. Baynes. Three and a half years Student and Assistant with Mr. Carr-Robinson, Hull. Six months Analyst at Messrs. Johnson Bros., Hull. At the present time Partner with Mr. James Baynes. Holder of Elementary, Advanced, and Honours Certificates, South Kensington.

Jas. Baynes. Walter Jenkins.
E. W. T. Jones. *Bernard Dyer.*
Otto Hehner.

Frankenbacher, Alexander, known as **Alexander F. Fuerst, Dr. Phil.,**

30, Belsize Road, N.W.

Chemist at Wood Street Smelting Works, E.C. Studied Chemistry and Physics at the Stuttgart Royal Polytechnicum (three years), also Chemistry at Heidelberg under Professor Dr. Victor Meyer (one and a half years). Assistant Chemist at the Government Laboratory of Wurtemberg (Königliche Centralstelle für Gewerbe und Handel, Stuttgart (three years).

John Spiller. Thos. Tyrer.
Geo. Bult Francis. Henry de Mosenthal.
Watson Smith. *Charles Dreyfus.*
David Howard.

Gilbard, John Francis Hutchins,

362, Mare Street, Hackney.

Assistant to Dr. Bernard Dyer, now and during the last six years. Formerly Student at Finsbury Technical College. Honours Certificates in Practical and Theoretical Inorganic Chemistry and Advanced in Organic Chemistry, physics, Physiology, &c., South Kensington. Joint Author of sundry papers on "Food Analysis" &c., in *Analyst* and *J. Soc. Chem. Ind.*

Bernard Dyer. E. W. Voelcker.
W. Lapraik. Charles E. Cassal.
R. Meldola. Otto Hehner.
Edward Bevan.

Goddard, Wm.,

11, Granville Road, Middlesbrough.

Lecturer in Physics for Evening Classes, Middlesbrough Science School. First Class Theoretical and Practical Chemistry, Science and Art Department, and also Honours Practical. Inter. B.Sc., London. Have also been engaged in teaching Chemistry for some time.

Alexander Scott.	Jno. A. Jones.
Weldon Hanson.	*J. E. Stead.*
H. Frankland.	*W. J. Sell.*
T. H. Easterfield.	*C. H. Ridsdale.*

Grant, Patrick Hope,

57, S. Guildry Street, Elgin, N.B.

Lecturer on Chemistry and Physics. Matriculated Student of Central Technical College, City and Guilds of London Institute (1889–92). Associate of Central Technical College, 1892. Assistant Master at Alleyn's School, Dulwich, and Demonstrator St. Thomas Charterhouse Science School (1892–93). At present Science Master Elgin Academy, and Lecturer on Chemistry and Physics at Victoria School of Science and Art, Elgin.

Henry E. Armstrong.	Gerald T. Moody.
W. J. Pope.	John S. Pilley.

E. C. Thompson.

Greaves, William Abraham,

Bankside, Golden Valley, Alfreton.

Science Master in Grammar School (Newark). B.Sc. (London), 1894. Branches II, III, IV. Three years as Science Master at the Grammar School, Market Rasen. Former Student at University College, Nottingham. Desiring admission with view to working for D.Sc. degree.

Frank Clowes.	R. Lloyd Whiteley.
J. Bernard Coleman.	William Marshall.
S. J. Pentecost.	*William Briggs.*

Gunn, Alexander,

66, Finsbury Park Road, N.

Chemist and Analyst to the North London Chemical Works. Author of "A new method for the detection and estimation of Oxalic Acid," *Pharm. Journ.*, Nov. 18, 1893. "The treatment of emulsions formed in the course of estimating alkaloïds," *Chem. and*

Drug., Oct. 13, 1894. "A new reaction illustrating the phenomenon of dissociation," *Chem. News*, Nov. 9, 1894. &c.

Fred W. Fletcher.	Peter MacEwan.
John Moss.	John Attfield.
Adam Gibson.	*Alfred H. Allen.*

Wyndham R. Dunstan.

Haller, H. Loft,

27, Hilda Street, Beverley Road, Hull.

Analytical Chemist. Four and a half years in the laboratories of Jas. Baynes, Esq., F.C.S., County and Borough Analyst, Hull. Latterly as Assistant, and the past two and a half years as Senior Assistant to Francis Sutton, Esq., Norwich.

Francis Sutton.	Jas. Baynes.
Hy. Austin Appleton.	F. Napier Sutton.

John R. Skelton.

Jones, Evan Lewis,

4, Bank Buildings, Llandilo.

Science Teacher at Hingham Grammar School, Attleboro', Norfolk. Studied Chemistry, 1888–89, at University College, Aberystwyth, and 1889–92 at the University of Cambridge, where I graduated. December, 1892, in the Chemistry Special, and have since been engaged in teaching Chemistry.

M. M. Pattison Muir.	A. Hutchinson.
W. J. Sell.	H. J. H. Fenton.

H. Lloyd Snape.

Marchant, Robert Charles,

18, Westfield Park, Redland, Bristol.

Land Steward. Member of the Royal Agricultural College, also of the Royal Agricultural Society of England (by examination). Student in Chemistry—more especially that portion connected with Agriculture.

Edward Kinch.	Cecil Cooke Duncan.
James Hendrick.	*J. William James.*

G. P. Darnell Smith.

Marsden, Prosper Henry,

47, Alma Road, Birkdale.

Pharmaceutical Chemist. Student at the Peter Street and Central Hr. Gd. Bd. Schools (evening classes), Manchester, under Mr. R. L. Taylor. Attended three courses of instruction in Theoretical and Practical Chemistry at the Pharmaceutical Society's School under Professors Dunstan and Attfield. Passed the Major examination of the Pharmaceutical Society, 1893, and am desirous, above all, of maintaining my acquaintance with Chemistry.

Wyndham R. Dunstan.	John Attfield.
Joseph Ince.	M. Carteighe.
R. L. Taylor.	W. H. Symons.
W. A. H. Naylor.	*M. Conroy.*

William Elborne.

McGlashan, John,

Cawnpore Sugar Works, Cawnpore, India.

Technical Chemist. Two years as a Student and two years as Assistant with Messrs. Wallace, Tatlock, and Clark, Glasgow. Latterly Assistant to Mr. Tatlock. Six years Chemist with Messrs. Walker, Sugar Refiners, Greenock.

D. R. Steuart, F.I.C.	R. R. Tatlock.
Horatio Ballantyne.	T. L. Patterson.

John Wm. Biggart.

Morrell, Robert Selby,

Gonville and Caius College, Cambridge.

Demonstrator in the Laboratory of Gonville and Caius College. M.A. of Cambridge University and Ph.D. of Würzburg University. Has published in the Society's Proceedings with Dr. Ruhemann two papers entitled:—1, "Action of Ammonia on Ethereal Salts of Organic Acids." 2, "Dicarboxyglutaconic Acid;" also with Dr. Ruhemann in the *Berichte der deutschen Chemischen Gesellschaft.* "Ueber den Aminoäthylendicarbonsäure ester;" also with Professor Emil Fischer, of Berlin, in the same Journal, "Ueber die Configuration der Rhamnose und Galactose."

G. D. Liveing.	M. M. Pattison Muir.
S. Ruhemann.	A. Hutchinson.

H. J. H. Fenton.

Newton, Charles Butterworth,

Gas Works, Rotherham.

Gas and Water Engineer to the Corporation of Rotherham. Honours Medallist in Gas Manufacture, City and Guilds of London Institute. Practically engaged in the manufacture of coal-gas, and in the utilisation of the bye-products therefrom. Late Chemist and Assistant Manager to the Shrewsbury Gas Works.

Leonard Temple Thorne.	J. Holliday.
Thos. P. Blunt.	*A. J. Greenaway.*
R. J. Friswell.	*Charles E. Groves.*

Patterson, Lama Gray,

Washington, Pennsylvania, U.S.N.A.

Chemist of the Washington Carbon Company. Late Acting Professor of Chemisty and late Chemist in the Agricultural and Mechanical College of Mississippi. Chemist of the Mississippi Agric. Experiment Station. Now Chemist of the Washington Carbon Co. (manufacturing carbon pencils for production of electric light).

J. W. Mallet. F. P. Dunnington. W. G. Brown.
F. P. Venable. *Theodore E. Wormley.*

Shaw, George Elliott,

9, Basing Road, Westbourne Park.

Analyst at Messrs. Howards and Sons, Stratford. Certificate of Chemical Department, Finsbury Technical College, Sessions 1887—1889. Associateship of Institute of Chemistry, January, 1893. Note on Hexa Iodobenzene, *Chem. News*, September 16, 1892.

David Howard. R. Meldola. Alfred G. Howard.
Julian A. Baker. Chas. Mills.

Slocum, Frank L.,

Pittsburgh, Pa., U.S.A. (Linden Ave, E.E.).

Chemist and Chemical Engineer. Editor Gas Dept., *American Manufacturer.* Graduate in regular collegiate course. Graduate of Philadelphia College of Pharmacy, and Assistant to Professor Ulaisch, at the time. Graduate of University of Strassburg, Germany, under Fittig and Kundt. Original work on β-Phenyllactic acid, published in *Annalen.* Have published work in *Amer. Journ. Pharmacy*, and *American Manufacturer.* Discovered and introduced new method of producing Cu_2O_2 and pure metallic chromium; also a new method and machine for removing ammonia from gas.

Sydney Young. Ludwig Mond.
Robert Ludwig Mond. Charles M. Stuart.
Arthur Richardson.

Squance, Thomas Coke, M.D., M.S., Lic. San. Sc., F.R.M.S., F.R.Met. Soc., &c.,

4, Beauclerc Terrace, Sunderland.

Doctor of Medicine. Physician and Pathologist to the Sunderland Infirmary. Consulting Physician to Monkwearmouth Hospital. Medical Officer of Health, Sunderland Union Rural Sanitary Authority, &c. As a Student attended the late Professor Marreco's lectures for one year, also a year's work in laboratory for M.B. and Lic. San. Sc. examinations. As M.O.H., have been engaged in food and water analyses. Have contributed papers on Pathological and other subjects to various Journals. Lecturer on Hygiene to Nursing Staff of Sunderland Infirmary, &c.

W. F. Keating Stock.
W. Dixon.
Otto Hehner.
Charles Ekin.
E. F. Harrison.
Alfred H. Allen.
M. Carteighe.
Bennett H. Brough.

Stansfield, Alfred, B.Sc.,

21, Markham Square, S.W.,

Assistant in the Metallurgical Department of the Royal College of Science. Has conducted numerous researches on alloys in Professor Roberts-Austen's laboratory, at the Royal Mint; accounts of which are given in the 2nd and 3rd reports (1893 and 1895) to the Alloys Research Committee of the Institution of Mechanical Engineers. He obtained an Honours Associateship of the Royal School of Mines, and a First Class in the Honours B.Sc. examination of the University of London.

W. C. Roberts-Austen.
T. K. Rose.
F. W. Bayley.
Bennett H. Brough.
W. Palmer Wynne.

Theodosius, Alfred F., B.A. (Oxon.),

Magdalen College School.

Science Master, Magd. College School. Honours Natural Science School, Oxford.

V. H. Veley.
John Watts.
W. W. Fisher.
J. A. Gardner.
J. E. Marsh.
William Odling.

Thomson, Wm. Thomas,

Austin Villas, Station Road, Waltham Cross, Herts.

Analytical Chemist. For four years Assistant in City Analyst's Laboratories, Glasgow. For three years Chemist in charge Nitro Glycerine Factory. For one year Chemist in charge Gun Cotton Factory.

Henry E. Armstrong.
Horatio Ballantyne.
Robert R. Tatlock.
William Rintoul.
Alfred H. Allen.

Thornton, Arthur,

67, St. Mary's Terrace, Manningham, Bradford, Yorks.

Senior Science Master, Bradford Grammar School. Teacher of Chemistry, Bradford Grammar School, one year. Teacher of Chemistry, Ipswich School, two years. Teacher of Chemistry, Giggleswick School, three years. M.A. Cambridge. Late Scholar Christ's College, Cambridge. First Class (Chemistry, Physics, Mineralogy), Natural Sciences Tripos, 1887.

A. Hutchinson.	Sidney Skinner.
H. J. H. Fenton.	T. H. Easterfield.
Arthur Smithells.	

Trehärne, Frederick Gwilym,

Llynderw, Llanishen, near Cardiff.

Analytical Chemist. I have been engaged for some years in Analytical work, making a special study of Coal. I am anxious to be a Member, so that I may enjoy the privilege of having the Society's Journal.

W. H. Symons.	Henry O. Huskisson.
Samuel Rideal.	*George S. Taylor.*
T. H. W. Idris.	*J. Hughes.*

Ward, George John,

The Cottage, Hallam Fields, Ilkeston.

Manager of Blast Furnaces, Stanton Ironworks. Student for three years in the University College, Nottingham, mainly in Chemistry, but also in Physics and in Natural Science. For three years Analyst to the Stanton Ironworks, and for two years (and at present) Manager of the Blast Furnaces of the Stanton Ironworks. Member of Committee of Nottingham Section of Society of Chemical Industry.

Frank Clowes.	J. Bernard Coleman.
R. Lloyd Whiteley.	*S. J. Pentecost.*
L. Archbutt.	

Warwick, Arthur William,

Minah Mine, Wickes, Montana, U.S.A.

Metallurgical Chemist. Has studied Chemistry and Metallurgy at the Royal College of Science, South Kensington. Formerly an Assistant in the Research Laboratory of the Royal College of Science.

T. E. Thorpe.	F. R. Japp.
J. W. Rodger.	Chapman Jones.
A. E. Tutton.	William Tate.

Wigley, Henry F. A.,

64, Quentin Road, Lee, S.E.

Head-Assistant and Science Master, Roan School, Greenwich.

B.A. Interm. B.Sc. (Lond. Univ.). Special Study: Agricultural Chemistry, with Analysis of Manures, Soils, Foods, &c. Chemistry Teacher, Roan School, and Student at Goldsmiths' Institute, New Cross.

George T. Holloway. William Briggs, M.A., LL.B.
Charles S. Ellis, A.I.C. Ernest A. Smith.
William Ping.

Whiston, William Arthur,

Collegiate School, Llandudno.

Teacher (and Principal of School of 70 boys). Student at Mechanics' Institute, Crewe. Student at Cambridge Laboratory, Summer Course. Science Teacher here for four and a half years, and formerly at Cotes Hall College. Greatly interested in the branch of Chemistry relating to Photography, especially its recent developments.

R. Lloyd Whiteley. H. J. H. Fenton.
James J. Dobbie. *Frank Clowes.*
S. J. Pentecost.

Wilson, John,

11, Cupar Road, Battersea, London, S.W.

Demonstrator and Assistant Lecturer in Chemistry, Battersea Polytechnic Institute. B.Sc., First Class Honours, Chemistry (Victoria). Student of Owens College, 1891–94.

Harold B. Dixon. W. H. Perkin, jun.
G. H. Bailey. Bevan Lean.
Samuel H. Davies.

Proposed by the Council under Bye-law 1 (3).

Eutroppe, Arthur T.

New Whatcom, Washington, U.S.A.

Chemist and Assayer. Three years a Student at the Sydney Technical College, Honours, Second Year, in Practical Chemistry, and Examiner's Special Prize. Now engaged in my own laboratory.

Will. A. Dixon, F.I.C. George A. Byrn.

Sorabji, Kekhasrie, Engineer.

Marine Lines, Bombay.

Assistant Surgeon, Bombay Medical Service. Licentiate in Medicine and Surgery, Bombay University. Lecturer in Chemistry,

Pharmacy, Materia Medica, and Botany.—Ag. Assistant Chemical Analyser to Government Bombay. Bomanji Sorabji, C.E., Ph.D.
Bomanji Sorabji, C.E., Ph.D. Thomas Stephenson.
Benjamin Phillips.

HARRISON AND SONS, PRINTERS IN ORDINARY TO HER MAJESTY, ST. MARTIN'S LANE.

Issued 31/5/1895.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

EDITED BY THE SECRETARIES.

No. 152. Session 1894–95.

May 16th, 1895. Mr. A. G. Vernon Harcourt, President, in the Chair.

Certificates were read for the first time in favour of Messrs. John Croysdale, The Grange, Whitley Bridge, R.S.O.; Joseph Lones, Lansdowne, South Road, Smethwick; Arthur E. Potter, M.A., B.Sc., Rangoon; E. J. Read, B.A., 2, Leigh Terrace, Bedford.

The following were duly elected Fellows of the Society.

Harold Allden Auden, B.Sc.; Edgar S. Barralet; Eugen Blume; Lancelot Alexander Borradaile, B.A.; Henry Bradford; Gustav Theodore Bruckmann, B.Sc.; Walter W. Cheadle, B.A.; Virgil Coblentz, Ph.G., A.M., Ph.D.; Herbert William Cook, B.Sc.; Edric Druce; Arthur T. Eutroppe; Sydney Fawns; Hasslewood Irving Foster; Alexander F. Fuerst, Ph.D.; John Francis Hutchins Gilbard; William Goddard; Patrick Hope Grant; William Abraham Greaves, B.Sc.; Alexander Gunn; H. Loft Haller; Evan Lewis Jones, B.A.; Robert Charles Marchant; Prosper Henry Marsden; John McGlashan; Robert Selby Morrell, M.A., Ph.D.; Charles Butterworth Newton; Lama Gray Patterson; George Elliott Shaw; Frank L. Slocum; Kekhasrie Engineer Sorabji; Thomas Coke Squance, M.D., M.S.; Alfred Stansfield, B.Sc.; Alfred F. Theodosius, B.A.; William Thomas Thomson; Arthur Thornton, M.A.; Frederick Gwilym Trehärne; George John Ward; Arthur William Warwick; Henry F. A. Wigley, B.A.; William Arthur Whiston; John Wilson, B.Sc.

Of the following papers those marked * were read.

*65. "Kjeldahl's method for the determination of nitrogen." By Bernard Dyer, D.Sc.

This method, variously modified, has, in most agricultural laboratories, superseded the well-known soda-lime method, over which it possesses marked advantages for the analysis of feeding stuffs and fertilisers. It has not, however, been generally adopted by scientific chemists, and little information is available as to its applicability to different types of organic compounds. To supply such information was the object of the present investigation.

The best modification of the method, in the author's experience, for the analysis of feeding stuffs and fertilisers not containing nitrates, and applicable, as will be seen, to a large number of organic compounds, is the Kjeldahl-Gunning method modified, however, by the use of mercury. A suitable quantity of the material to be analysed is mixed in a round-bottomed, hard glass flask, with 20 c.c. of strong sulphuric acid and a drop of mercury, and warmed for a short time, when 10 grams of potassium sulphate are added. The contents of the flask are then boiled until colourless. With many materials this result happens within half an hour, and it is rarely deferred beyond an hour. The contents are washed into a distilling flask, mixed with excess of soda and a little potassium sulphide (to decompose mercury compounds), and the ammonia then distilled off into standard acid, which is afterwards titrated in the usual way. No spray trap is necessary in distilling if the connection between the distilling flask and receiver is made by means of a long, block-tin tube, rising perpendicularly 15 or 20 in. from the neck of the flask. The author prefers not to use a condenser, but to drive the steam directly into the standard acid, which stands in a trough of cold water, the delivery tube terminating in a pear-shaped glass bulb, to prevent regurgitation of the acid. The use of mercury is not necessary, but materially expedites the process.

When nitrates are present, or nitro-compounds and certain other compounds referred to in the paper, Jodlbaner's modification is used. This consists in dissolving in the sulphuric acid used for oxidation a small quantity (about 2 grams for a single determination) of phenol or salicylic acid. The nitrogen in the nitrate or nitro-group then forms a nitro-compound with the sulphonated phenol or salicylic acid. In many cases it is highly important that the sulphuric acid containing the phenol or salicylic acid should be poured directly and suddenly on to the material contained in the flask, so as to submerge it immediately, and not to let it trickle from a pipette. If nitrates and ammonium salts are both present, loss of nitrogen occurs, unless this precaution is observed; this does not appear to be generally known, and probably often gives rise to errors. One or two grams of zinc dust (as well as a drop of mercury) are dissolved in the contents of the flask while still cold. The process is then continued exactly as before.

The method first described as the "Kjeldahl-Gunning" method was found to give very nearly the exact percentages of nitrogen in uric acid, asparagine, caffeine, indigotine, morphine, quinine, strychnine, aniline, atropine, diphenylamine, naphthylamine, acetanilide, ortho-benzoic sulphinide, sulphamido-benzoic acid, pyridine, benzidine, aldehyde ammonia, and nitroso-di-methyl-aniline.

The Jodlbauer modification referred to by the author as the "Kjeldahl-Gunning-Jodlbauer" method, was found to give nearly correct percentages of nitrogen in potassium nitrate, ammonium nitrate, urea nitrate, nitrobenzene, nitronaphthalene, nitraniline, dinitrobenzene, trinitrophenol, and potassium para-bromo-chlor-nitrophenol.

It might be expected that reduction with zinc alone, without the use of phenol or salicylic acid, would suffice in the case of aromatic nitro-compounds. The author finds, however, that if zinc alone be used with aromatic nitro-compounds there is loss of nitrogen, as though it were necessary that more carbon should be present.

The Kjeldahl-Gunning method fails to furnish the calculated quantity of nitrogen in azobenzene or amido-azobenzene. The loss in the former case was small; in the latter case it amounted to nearly 50 per cent. Mere reduction by zinc suffices with amido-azobenzene, but in the case of azobenzene the complete Jodlbauer modification is necessary. With amido-azotoluene the correct amount was obtained by the Kjeldahl-Gunning process supplemented by reduction with zinc and with carbazol by the Kjeldahl-Gunning method alone.

Hydroxylamine hydrochloride, which contains 20·21 per cent. of nitrogen, yielded only 3 per cent. by the Kjeldahl-Gunning method; by reduction with zinc about 10 per cent. was obtained; by the Kjeldahl-Gunning-Jodlbauer method about 19 per cent.; by reduction with sugar and zinc less than 19 per cent. The Kjeldahl-Gunning-Jodlbauer method, with the addition of sugar as well as zinc, however, gave the calculated quantity in each of three separate determinations. Acetaldoxime, by the Kjeldahl-Gunning method, gave somewhat low results, but with the addition of sugar and zinc furnished correct results. Naphthoquinone-oxime yields its full percentage by the Kjeldahl-Gunning method.

Potassium cyanide and ethyl cyanide both give nearly correct results by the Kjeldahl-Gunning method; no trace of hydrocyanic acid is evolved if the sulphuric acid used is strong. Potassium ferrocyanide also yields accurate results. Potassium ferricyanide, however, only gives sufficiently accurate results when reduced by the addition of sodium thiosulphate. Sodium nitroprusside failed with any modification of the method to yield all its nitrogen.

Phenyl-hydrazine derivatives cannot by any modification of the method tried by the author be made to give correct results ; there is invariably loss of nitrogen, presumably liberated in the free state. The derivatives used were phenyl-hydrazinehydrochloride and glucosazone. Symmetrical di-phenyl hydrazine, or hydrazobenzene, affords accurate results with the Kjeldahl-Gunning method. This substance, however, ceases to be a hydrazine when dissolved in acid, as it is converted into benzidine which furnishes the calculated amount of nitrogen.

DISCUSSION.

Dr. KIPPING remarked that Dr. Dyer's results pointed to the conclusion that different types of organic compounds required special treatment in order to obtain the whole of the nitrogen as ammonia, whilst some compounds did not under any conditions furnish accurate results. The method could not therefore be regarded as a substitute for the absolute method of Dumas.

Mr. HEHNER said that few analytical processes had been the subject of so much investigation as the Kjeldahl method, the original process having undergone very many modifications. Originally the oxidation was carried out only very partially by sulphuric acid, potassium permanganate being used as soon as the acid had produced charring. Kjeldahl had found that by the action of the acid alone only about 25 per cent. of the total nitrogen in quinine, and about 40 per cent. of the nitrogen in morphine, was obtained, whilst after the action of permanganate almost the whole of the nitrogen appeared as ammonia. The use of permanganate had already been recognised as leading to the loss of nitrogen, and Kjeldahl had himself pointed out that the heating after the addition of permanganate must be moderate, or loss may occur. Much of the ground occupied by Dr. Dyer's paper had already been gone over by others, especially by Arnold and Wedemeyer. Taking into account the results obtained by the various investigators of the process, it might be said that the Kjeldahl process, as modified by Wilfarth, Gunning, and Jodlbauer, was a most accurate and convenient one for the determination of nitrogen in naturally occurring nitrogenous substances, especially in feeding materials.

Dr. MORRIS considered that there was no doubt as to the value of Kjeldahl's process for determining nitrogen in proteids and similar nitrogenous compounds. He had found it advantageous to use permanganate as originally suggested by Kjeldahl.

Professor DUNSTAN suggested the stability of hydroxylamine sulphate as a probable explanation of the small amount of ammonia furnished by hydroxylamine salts in the absence of a special reducing agent. The subsequent action of alkali on the sulphate would liberate only a part of the nitrogen as ammonia. Similarly with oximes, some hydrolysis would occur, producing hydroxylamine sulphate, although here the decomposition of the hydrocarbon radicle would ensure nearly complete reduction of the oximido-group to ammonia.

*66. "Note on liquation in crystalline standard gold." By T. K. Rose, D.Sc., A.R.S.M., Assistant Assayer of the Royal Mint.

It has been suggested by Roberts-Austen that, although no segregation occurs on the solidification of alloys of gold with silver and copper, some rearrangement might be expected to take place when these alloys are made crystalline and brittle by the addition of small quantities of bismuth or lead. The author accordingly rendered standard gold impure in three successive experiments by the addition of 0·2 and 0·4 per cent. of bismuth and 0·2 per cent. of lead respectively, casting the metal in a spherical iron mould, and assaying various parts of the mass.

The observed variations in the composition of different parts of the mass can be explained by assuming that in these alloys a saturated solution of gold and silver in bismuth or lead (no doubt containing a little copper in addition) remains molten after the greater part of the gold and copper has solidified. Those constituents which are the first to become solid are thus enabled to assume a definite crystalline form. Moreover, as the portion of the material which remains molten longest is pushed towards the centre of the mass during cooling, the interior is enriched in both gold and silver.

*67. "Preparation of the active lactic acids and the rotation of their metallic salts in solution." By T. Purdie, Ph.D., B.Sc., and J. Wallace Walker, M.A.

The authors have prepared the active lactic acids in considerable quantity by the process previously described (Trans., 1893, **63**, 1143) using certain modifications, and have used the material thus obtained for examining the optical activity of some of the metallic lactates in aqueous, alcoholic, and aqueous-alcoholic solutions of varying equivalent concentrations. The freezing points of a number of the same solutions were also determined with the double object of obtaining an approximate estimate of the amount of dissociation attending the changes in molecular rotation, and of detecting the existence or non-existence of racemoid compounds in solution.

The salts examined were those of lithium, sodium, potassium, silver, calcium, strontium, barium, magnesium, zinc, cadmium, and zinc-ammonium.

All these salts in aqueous solution within the limits of concentration used were found to be active in the opposite sense to that of the acid from which they were prepared, and the activity was found to increase with dilution, except in the case of the silver salt, the rotation of which undergoes a slight decrease.

The salts of the alkaline metals comprising those of silver, also those of barium and strontium, tend to a common maximum molecular rotation of about 14·5°, an observation which is in accordance with the law of Oudemans. The salts of the other metals show divergencies from this law which indicate that the activity of their solutions cannot be accounted for by the presence of simple molecules and ions alone, but that it is probably largely influenced by the formation of molecular aggregates, whose activity differs widely from that of the other factors. This assumption is confirmed by observations of the rotation of the sodium and potassium lactates in alcohol and of other salts in aqueous alcohol.

A comparison of the freezing points of solutions of active and inactive lithium and strontium lactates shows that the racemoid salts are resolved into their components in aqueous solution. The corresponding coefficients of depression of the barium salts show slight differences which may possibly be due to the presence of racemoid salt.

68. "Derivatives of succinyl and phthalyl dithiocarbimides." By Augustus E. Dixon, M.D., and R. E. Doran.

On heating together lead thiocyanate, succinyl chloride, and dry benzene, succinyldithiocarbimide is formed and goes into solution, $C_2H_4(COCl)_2 + Pb(SCN)_2 = PbCl_2 + C_2H_4(CO{\cdot}NCS)_2$.

It is a pungently smelling, very unstable compound, soluble in all proportions in benzene, decomposed by water into succinic and thiocyanic acids, and easily desulphurised by silver or alkaline lead salts.

The benzene solution yields, on the addition of bases, the corresponding symmetrical dithioureas. From aniline, *succinyldiphenyldithiourea* was obtained, $C_2H_4(CO{\cdot}NH{\cdot}CS{\cdot}NHPh)_2$. This forms silky needles (from hot acetic acid), sparingly soluble in most solvents, and melting with decomposition at 210—210·5° (corr.). The compound is readily desulphurised by ammoniacal silver nitrate in the cold, or by warming with alkaline lead tartrate. It dissolves in warm dilute caustic alkali, thereby breaking up into phenylthiourea and succinic acid; and is decomposed by alcoholic ammonia, under pressure, forming phenylthiourea.

Succinyldiorthotolyldithiourea, $C_2H_4(CO{\cdot}NH{\cdot}CS{\cdot}NH\textit{o}\text{-}To)_2$, similarly prepared from *o*-toluidine (yield = 96 per cent.), formed colourless glassy needles, melting at 217—218°, and resembling in most other respects the corresponding phenyl compound.

Succinyldi-α-naphthyldithiourea was found to be practically insoluble in all the ordinary solvents; after washing with spirit, it formed a pure white powder melting at 224—225°, and desulphurised by lead or silver solutions.

From methylaniline, symmetrical *succinyldimethyldiphenyldithiourea* was obtained, $C_2H_4[CO{\cdot}N{:}C(SH){\cdot}NMePh]_2$, deposited from hot alcohol in rosettes of needles, m.p., 137—138°; resembling the preceding compound in properties, and decomposed by warm, dilute potash, forming unsymmetrical phenylbenzylthiourea (Werner, *Proc.*, 1892, 96).

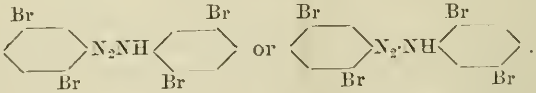
Succinyldiphenyldisemithiocarbazide, $C_2H_4(CO{\cdot}NH{\cdot}CS{\cdot}NH{\cdot}NHPh)_2$, from the thiocarbimide and phenylhydrazine, occurred in crystals, melting at about 220°. With anhydrous alcohol, the thiocarbimide afforded the *dithio-diurethane*, $C_2H_4(CO{\cdot}NH{\cdot}CS{\cdot}OEt)_2$; thick, white prisms, insoluble in water, soluble in alcohol, desulphurised by warming with ammoniacal silver or alkaline lead solutions, and melting at 166—167°.

From phthalyl chloride and lead thiocyanate, similarly, a solution of phthalyldithiocarbimide was prepared; it appears to be a crystalline solid, but could not be obtained in a pure condition. With *water*, it yields phthalic and thiocyanic acids; and combines with bases, like the succinyl analogue, forming thioureas the examination of which is not yet complete. The *aniline* derivative melted at 209—210°; the *orthotoluidine* and *benzylamine* derivatives at 152—153° and 163° respectively. Secondary *butylamine* produced a red oil, and *methylaniline*, vitreous prisms melting at 184—185°, and decomposed by fuming nitric acid, with production of a tetranitromethylaniline, $C_6H_2(NO_2)_3{\cdot}NMe(NO_2)$, m. p. 127°.

69. "The action of nitrous acid on dibromaniline, $C_6H_3BrBr{\cdot}NH_2$ = 1 : 4 : 2." By Raphael Meldola, F.R.S., and Ernest R. Andrews.

During the course of some experiments on the dihaloid derivatives of *β*-naphthylamine which are still in progress it has been found that under certain conditions nitrous acid converts these compounds into diazoxides with the elimination of one atom of the halogen. In order to see whether this property was possessed by analogous compounds of the benzene series, paradibrombenzene was nitrated and converted by reduction into the dibromaniline, m. p. 51—52°, described by Meyer and Stüber (*Ann.*, **165**, 180). It is of interest to record that this dibromnitrobenzene cannot be reduced by zinc dust and acetic acid in alcoholic solution, in the same way that the corresponding naphthalene derivatives can be reduced to β-naphthylamine derivatives (Meldola and Desch, Trans., 1892, 768). In order to effect complete reduction, it is necessary to boil the alcoholic solution with tin and hydrochloric acid in the usual manner.

The conditions favourable for the formation of diazoxides in the naphthalene series, are that the diazotising operations should be carried out in presence of an excess of strong sulphuric acid and that the diazo-salt should be warmed with dilute sulphuric acid to complete the transformation. If these conditions are not complied with the diazoamido-compound is formed instead of the diazoxide. In the present case therefore, the dibromaniline was dissolved in glacial acetic acid, an excess of strong sulphuric acid poured in. and a little more than the calculated quantity of sodium nitrite added in small portions with constant stirring; the solution was kept cooled during this operation. When all the nitrite had dissolved, the solution was very gradually diluted with water; a clear liquid was obtained and at this stage the solution no doubt contains the diazo-sulphate. On warming the solution for some hours nitrogen was evolved and a brown substance separated out. The latter was not soluble to any extent in boiling water and did not therefore appear to contain a diazoxide; it was not dissolved in appreciable quantity by dilute alkali and did not therefore contain anything phenolic. After many crystallisations from benzene, the compound was obtained in the form of brownish flattened needles melting at 234—235°. Analysis proved that it was the diazoamido-compound and that the formula was—



0·0838 gave 5·85 c.c. moist nitrogen at 12° and 752·3 mm. N = 8·19.
0·0975 ,, 0·1431 Ag Br. Br = 62·46.

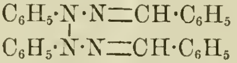
The formula requires N = 8·19 and Br = 62·38 per cent.

An attempt to transform this diazoamide into an amidoazo-compound was not successful; it decomposes very readily, forming dibromaniline, when treated with aniline and aniline hydrochloride in the usual way. The chief point of interest in the present note is the fact that this dibromaniline so readily forms a diazoamido-compound in presence of an excess of sulphuric acid. Analogous experiments without this excess of acid have led to similar results with the corresponding dichloraniline, but these are not so remarkable under the conditions specified (Zettel, *Ber.*, 1893, 2471; and Herschmann, *Ber.*, 1894, 767).

Tribromaniline, $C_6H_2{\cdot}NH_2{\cdot}Br{\cdot}Br{\cdot}Br = 1 : 2 : 4 : 6$, also fails to give a diazoxide when diazotised in the presence of excess of sulphuric acid.

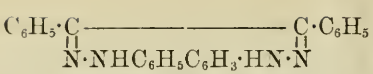
70. "A new modification of Benzilosazone." By Harry Ingle, Ph.D., B.Sc., and Harold H. Mann, B.Sc.

By the action of iodine on a mixture of benzalphenylhydrazone and sodium ethylate suspended in ether, the authors obtained two substances. On treatment of the mixture with ether or ethyl acetate, it was separated into its components.

The insoluble portion on recrystallising from benzene was obtained in difficultly soluble, silky, yellow needles, melting at 186° C., identical with dibenzaldiphenylhydrotetrazone already described by Minunni (*Gaz. Chim. Ital.*, **22**, 2, 217), and by v. Pechmann (*Ber.*, **26**, 1045), to which the formula  $\begin{array}{l} C_6H_5{\cdot}N{\cdot}N{=}CH{\cdot}C_6H_5 \\ \quad\;\; | \\ C_6H_5{\cdot}N{\cdot}N{=}CH{\cdot}C_6H_5 \end{array}$ has been assigned.

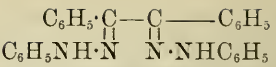
On evaporating off part of the solvent and adding alcohol to the residue, the soluble portion separated as a yellow crystalline powder. This proved to be a stereoisomeride of benzilosazone, and since it is the least stable the authors have named it α-benzilosazone.

α-Benzilosazone crystallises from a mixture of benzene and alcohol in faintly yellow-coloured prisms, melting at 208° C. On heating its solution in ethyl succinate, benzoate, or malonate to the boiling point, or by heating it in a sealed tube with alcohol to 210° C., it is changed into the normal or β-benzilosazone (m. p. = 225). Phenylhydrazine also brings about this change. When heated on the water-bath with alcoholic potash it is unchanged, unlike the isomeric dibenzaldiphenylhydrotetrazone which is converted by this treatment into β-benzilosazone by a remarkable intramolecular transformation. If the two osazones are treated with concentrated sulphuric acid, a wine red colour is in each case produced. On adding water to the sulphuric acid solutions and subsequently distilling in steam, the α-osazone yielded benzil, benzaldehyde, and triphenylosotriazole (Auwers and V. Meyer, *Ber.*, **21**, 2806), while from the β-osazone (m. p. = 225°) the two latter substances were not produced. These facts, by analogy with the decomposition of the stereoisomeric benzildioximes, lead the authors to assign the syn-configuration to the α- and the anti-configuration to the β-osazone.



$$\begin{array}{lcl} C_6H_5\cdot C & \text{————————} & C\cdot C_6H_5 \\ \quad \| & & \| \\ N\cdot NHC_6H_5C_6H_3\cdot HN\cdot N & & \end{array}$$

α-Benzilosazone, m. p. = 208°.
Benzilsynosazone.



$$\begin{array}{rcl} C_6H_5\cdot C & - & C\text{———}C_6H_5 \\ \| & & \| \\ C_6H_5NH\cdot N & & N\cdot NHC_6H_5 \end{array}$$

β-Benzilosazone, m. p. 225°.
Benzilantiosazone.

This view is supported by the fact that the α-compound is the more easily oxidised. The two osazones show also different solubilities in various liquids.

The experiment of v. Pechmann (*loc. cit.*), who oxidised benzalphenylhydrazone with amyl nitrite in ethereal solution, was repeated, and from the mother liquors the authors obtained a new substance, m. p. = 202°. Analysis showed it to be isomeric with the compounds before mentioned, but it differed from them in not being changed by alcoholic potash, or by heating with ethyl succinate; but, like the hydrotetrazone, it was reduced by phenylhydrazine to the original benzalphenylhydrazone. The constitution of this substance has not yet been determined with certainty.

71. "Affinity of weak bases." By J. Walker, D.Sc., and E. Aston, B.Sc.

A method is described for estimating the strength of organic bases such as aniline from the rate at which equivalent solutions of their hydrochlorides invert cane-sugar at 60°. The results obtained are, as a rule, in agreement with those of previous experimenters. The same method applied to the nitrates of cadmium, zinc, lead, and aluminium gives the bases of these salts in the order of strength named.

72. "Substitution-derivatives of urea and thiourea." By Augustus E. Dixon, M.D.

During the course of an investigation in which the author was engaged, it became necessary to verify the melting points of certain urea and thiourea derivatives, and to obtain data regarding a number of compounds, hitherto unknown, belonging to the above classes. The following substances are described.

Trimethylthiourea—Thick, pointed prisms, very freely soluble in water, alcohol, and chloroform; desulphurised by silver, but not by alkaline lead solution, and melting at 87—88°.

Tribenzylthiourea forms silvery prisms, m. p. 114·5—115·5°; insoluble in water, difficultly soluble in alcohol, freely in chloroform and benzene; decomposed on distillation.

Phenylmetatolylthiocarbamide, PhNH·CS·NHTo—Vitreous prisms, insoluble in water, soluble in alcohol, ether, acetone, &c., and melting at 91—92°.

Orthoparaditolylthiocarbamide, $CS(NHTo)_2$—Hard prisms, m. p. 172—173°, apparently undecomposed.

Phenylmetaxylylthiocarbamide—White needles, melting at 125·5—126°; almost insoluble in water, sparingly soluble in cold alcohol, freely in chloroform.

Paratolyldibenzylthiourea, $ToN{:}C(SH){\cdot}NBz_2$—Short thick prisms or long slender needles (from alcohol), m. p. 145—146°; desulphurised by ammoniacal silver nitrate only on boiling, and not at all by alkaline lead solution.

Isobutylurea, spermaceti-like needles, becoming strongly electrical on friction; m. p. 140·5—141·5°; freely soluble in water and alcohol.

sec.-butylurea—Large flattened prisms, freely soluble in water, alcohol, and hot acetone; m. p. 169—170°.

Diisobutylurea, $CO(NH\textit{i}\text{-}Bu)_2$—Prepared from the corresponding thiocarbamide and silver nitrate; it occurred in white needles, m. p. 135—136°.

Di-sec.-butylurea, $CO(NH\textit{s}\text{-}Bu)_2$, from sec.-butylurethane and sec.-butylamine; pearly flattened needles, melting at 137—138°.

ab-Methylphenylurea, $MeNH{\cdot}CO{\cdot}NHPh$—broad white prisms, moderately soluble in hot water, and melting at 150·5° and 151·5°, undecomposed.

ab-sec.-Butylphenylurea—large prisms (from hot alcohol); m. p. 155·5—156·5° without decomposition; insoluble in hot water.

ab-Phenylmetatolylurea and *ab-Phenylparatolylurea*—White needles, melting at 173—174° and 212—213° respectively.

ab-Orthoparaditolylurea—Flexible needles, melting at 263—264°.

ab-Ethylbenzylurea—Long silky prisms, becoming very electrical on rubbing; m. p. 104—105°.

ab-Benzylorthotolylurea—Small, vitreous prisms (from alcohol); m. p. 188—188·5°; insoluble in water.

ab-Benzylmetatolylurea—Flexible, silvery needles, insoluble in water, freely soluble in hot spirit, and melting at 158·5—159°.

Methylphenylbenzylurea, $MeNH{\cdot}CO{\cdot}NPhBz$, from the corresponding thiourea and silver nitrate, occurs in pearly white crystals of m. p. 107·5—108·5, insoluble in water, very freely soluble in alcohol, ether, and chloroform.

ab-Allylphenylurea was found to melt at 114·5—115·5°, instead of 96—97°, as recorded by Maly.

The author suggests an addition to the nomenclature of thiourea-derivatives, with a view of rendering it more explicit.

73. "Note on some reactions of ammonium salts." By W. R. E. Hodgkinson and N. E. Bellairs, Lieut. R.A.

From the results of some experiments on metals and strong ammonia solution in presence of air (Proc., **146**, 9), the authors were led to examine the action of some metals on so-called ammonium salts. They chose for this purpose such salts of oxy-acids as may be melted in a comparatively dry state without appreciable decomposition.

So far they have only examined the nitrate and sulphate. These salts were dried and carefully melted, and the metal, in foil or thin sheet, introduced. The temperature in each experiment was maintained a few degrees above the melting point of the salt.

Most of the experiments were quantitative.

Metallic copper acts immediately on the fused salts, ammonia gas and a little hydrogen being evolved. When the temperature is maintained below 160°, the residual product is a mixture of copper sulphate or nitrate with an excess of the ammonium salts; some water also escapes, and, in the case of ammonium sulphate, a small quantity of sulphite sublimes. Nickel and cobalt act in a similar manner, but more sublimate of sulphite is obtained, and the amount of hydrogen is very small. Mercury does not act so readily, but similar products are formed. The most easily managed reactions are those with silver and palladium. Silver dissolves most easily both in ammonium sulphate and nitrate; the amount of displaced ammonia is nearly equivalent to the silver dissolved as sulphate or nitrate. It is doubtful whether any hydrogen escapes. With ammonium sulphate much sulphite sublimes.

Palladium is very nearly as active as silver, and the main difference seems to be that a pallad-ammonium salt is produced, whilst the silver merely forms nitrate or sulphate.

The ammonium group seems to be displaced and broken up by metals at temperatures just below those at which the salts undergo resolution if heated alone. In no case is the exact equivalent of ammonia to that of dissolved metal obtained. The metallic salt is always in excess, but silver dissolves more readily in fused ammonium sulphate than in sulphuric acid, probably owing to the easy fusibility of the mixed salts, silver sulphate and ammonium sulphate.

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I. *Donations.*

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Über die Einwirkung schwacher Affinitäten auf Aldehyd. Von Dr. Adolf Lieben. From the Author.

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Synthese von Alkoholen mittelst gechlorten Äthers. Von Adolf Lieben. 1866. From the Author.

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Nachschrift zur Abhandlung über Entstehung von Jodoform und Anwendung dieser Reaction in der chemischen Analyse. Von Adolf Lieben. From the Author.

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Synthese von Alkoholen mittelst gechlorten Äthers. Von Adolf Lieben. II. Abhandlung. Äthylirter Äthylalkohol. 1869. From the Author.

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Ueber den normalen Butylalkohol. Von Ad. Lieben und A. Rossi. 1871. From the Authors.

Zur Kenntniss der normalen Butylverbindungen und des Valeriansäureäthers. Von Ad. Lieben und A. Rossi. 1872. From the Authors.

Untersuchung der rohen Gährungsbuttersäure. Von G. B. Grillone. 1872. From the Author.

Verhalten des Aethers in Berührung mit verschiedenen Substanzen. Von Adolf Lieben. 1872. From the Author.

Zur Abwehr. Von Demselben. 1872. From the Author.

Ueber die trockene Destillation des ameisensauren Kalks. Von Ad. Lieben und E. Paternò. 1873. From the Authors.

Die Chemische Industrie. (Gruppe III.) Von Dr. Adolf Lieben. 1873. From the Author.

Über die in roher Gährungsbuttersäure enthaltene Capronsäure. Von Adolf Lieben. 1873. From the Author.

Über gährungscapronsäure Salze. Von Franz Kottal. 1873. From the Author.

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Anton Schrötter, Ritter von Kristelli. Eine Lebensskizze. Von Dr. Ad. Lieben. 1876. From the Author.

Über normalen Hexylalkohol und normale Önanthylsäure. Von Ad. Lieben und G. Janeček. 1877. From the Author.

Analisi di Quattro acque Potabili. Di Adolfo Lieben. 1879. From the Author.

Über Condensationproducte der Aldehyde und ihre Derivate. I. Abhandlung: Crotonaldehyd und seine Derivate. Von Ad. Lieben und S. Zeisel. 1880. From the Authors.

Reduction des Crotonchlorals. Von Ad. Lieben und S. Zeisel. 1880. From the Author.

Über Verbindungen von Chlorcalcium mit fetten Säuren. Von Adolf Lieben. 1880. From the Author.

Notiz über die Umwandlung der Meconsäure in Pyridin. Von Ad. Lieben und L. Haitinger. 1883. From the Authors.

Über Condensationproducte der Aldehyde und ihre Derivate. III. Abhandlung. Constitution des Butyrchlorals. Von Ad. Lieben und S. Zeisel. 1883. From the Authors.

Über Condensationproducte der Aldehyde und ihre Derivate. Von Ad. Lieben und S. Zeisel. II. Abhandlung. Methyläthylacroleïn und seine Derivate. 1883. From the Authors.

Untersuchungen über Chelidonsäure. Von L. Haitinger und Ad. Lieben. I. Abhandlung. 1884. From the Authors.

Untersuchungen über Chelidonsäure. Von L. Haitinger und Ad. Lieben. II. Abhandlung. Komansäure aus Chelidonsäure. 1885. From the Authors.

Über Condensationproducte der Aldehyde und ihre Derivate. Von Ad. Lieben and S. Zeisel. IV. Abhandlung. Tiglinaldehyd und seine Derivate. 1886. From the Authors.

Rede zum Gedächtniss an Ludwig. Barth. von Barthenau. Von Ad. Lieben. 1891. From the Author.

Über eine Fehlerquelle bei chemischen Operationen in Folge Verwendung von Gasflammen. Von Ad. Lieben. 1892. From the Author.

Über Darstellung von Crotonaldehyd. Von Ad. Lieben. 1892. From the Author.

Über Bestimmung von Ameisensäure. Von Adolf Lieben. 1893. From the Author.

Bemerkungen über die Constitution der fetten Säuren und die Löslichkeit ihrer Salze. Von Ad. Lieben. 1894. From the Author.

RESEARCH FUND.

A meeting of the Research Fund Committee will be held in June. Applications for grants, accompanied by full particulars, should be sent to the Secretaries before June 15th.

At the next meeting, on June 6th, the following papers will be read :—

"On the molecular refractions of dissolved salts and acids." By Dr. Gladstone, F.R.S., and W. Hibbert.

"A comparison of some properties of acetic acid and its chloro- and bromo-derivatives." By Spencer Pickering, F.R.S.

"$\beta\beta$-Dinaphthyl and its quinones." By F. D. Chattaway, D.Sc., Ph.D.

ERRATA.

TITLE-PAGES 1893 AND 1894.

Title-page, 1893, *for* "118—130" *read* "118—131."
,, 1894, ,, "131—144" ,, "132—145."

No. 151.

Page	Line
80	13, *for* "disulphonic" *read* "dichlorsulphonic."
84	25, ,, "product by" ,, "product is obtained by."
84	26, ,, "of" *read* "by."
87	32, ,, "next drop" *read* "molecular proportion."

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Issued 17/6/1895.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

EDITED BY THE SECRETARIES.

No. 153. Session 1894-95.

June 6th, 1895. Mr. A. G. Vernon Harcourt, President, in the Chair.

Messrs. G. E. Shaw, H. Thornton and H. F. A. Wigley were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. George Percy Bailey, B.A., 7, Mount Pleasant Square, Dublin; Charles James Fawel, The Laboratory, Cranford, Middlesex; Jervis E. Foakes, Medical School, Caxton Street, Westminster, S.W.; Stanley Fox, 46, Preston Street, Faversham; Rev. Henry Arthur Hall, M.A., The Schoolhouse, Totnes; James Henderson, B.Sc., 193, Blackness Road, Dundee; William Henry Pennington, Firedhouse, Rochdale; W. T. B. Ridge, 2, Ashwood Terrace, Longton, Staffs.; William Augustus Rugginz, 114, Upton Lane, Forest Gate, E.; W. T. Tibbald, 72, Lafayette Avenue, Detroit, U.S.A.; Harold E. Wright, Springhurst, Hartburn, Stockton-on-Tees.

It was announced from the Chair that on Thursday, June 20th, an Extraordinary General Meeting of the Society would be held at 8 P.M. to vote on the following change in the Bye-law which is proposed by the Council.

In Bye-law 1 to strike out the last paragraph, beginning "The life composition fee," and insert the following:—"The life composition fee shall be £30, excepting that Fellows who have paid 10 annual subscriptions shall pay as life composition fee £20; Fellows who have paid 15 annual subscriptions shall pay £15; Fellows who have paid 20 annual subscriptions shall pay £12, and Fellows who have paid 25 annual subscriptions shall pay £10."

Of the following papers those marked * were read.

*74. "The molecular refractions of dissolved salts and acids." By Dr. J. H. Gladstone, F.R.S., and Walter Hibbert.

In a paper on the Refraction Equivalents of the Elements (*Phil. Trans.*, 1870), Dr. Gladstone gave reasons for believing that the molecular refraction of a salt or acid is not altered when dissolved in water. Some controversy arose upon this point, and the refraction of salts in solution has been the subject of investigation by many experimenters. The present communication is devoted to a rigid examination of two of the reasons previously assigned.

1st. The similarity of the molecular refraction of substances when determined from the solid and from its solution.

2nd. That the molecular refraction of a dissolved salt is not affected by varying the amount of water.

The data employed in the present investigation are: Dr. Gladstone's former observations of 1869 and 1891, wherever sufficiently reliable; the published observations of other experimenters; and numerous series of observations recently made by Mr. Hibbert.

The results are arranged in tables. One of these exhibits the refraction values of all the solid salts which have been determined, provided they have but one index of refraction, together with a few others. These are compared with the refraction of the same salt in a nearly saturated solution. Another gives the same for anhydrous acids and their strong solutions. A third shows the effect upon refraction of diluting a strong solution of the salt or acid.

The combined results of these investigations are made apparent to the eye in five diagrams containing respectively the principal observations on the chlorides, the other haloïd salts, the nitrates, the sulphates, and the acids themselves. These diagrams represent the specific refractive energy of the substance before solution, and then upon the addition of varying proportions of water. By far the greatest change occurs with hydrochloric acid, which rises from 0·30 to nearly 0·39 when dissolved in 1·5 times its weight of water, and to 0·40 in very dilute solutions. Many other salts and acids show a distinct, but much smaller, increase, while in others, again, if there be any change, it is within the limits of errors of observation. Various points of relationship between these variations and the chemical nature of the binary compounds examined are pointed out.

This investigation explains some of the difficulties met with in the original determinations of refraction equivalents, and will be of great service in any future revision of them.

The general conclusion is that when a salt or acid dissolves in water the law of permanency of specific refractive energy, notwithstanding change of physical condition, does hold good, but that in many, if not most, cases there is some circumstance which causes a slight departure from it, while with the "strong acids" the departure is considerable. This change takes place principally in the initial stage of solution of the solid or liquid compound; but in many cases a small further change is discernible as more and more water is added; but this soon becomes inappreciable. This change is, in some cases, in the direction of an increased refraction, especially in the haloïd salts and the acids; in other cases, especially the nitrates and salts of low refractive energy, this change is in the opposite direction. In either case the dilution effect is in the same direction as that due to solution. In a few cases, where the dispersion was capable of being estimated, the change in it was found to be proportionally greater than the change in the refraction itself. The origin of this refraction change is at present obscure, but it probably arises from some gradual change in the arrangement of the atoms or molecules of the salt or acid under the influence of water; and there are clear indications of some connection between the amount of this change and the amount of the specific refractive energy of the salts themselves. It stands also in some relation to the phenomena of electric conductivity, and especially of magnetic rotation.

*75. "A comparison of some properties of acetic acid, and its chloro- and bromo-derivatives." By S. U. Pickering, F.R.S.

The properties which have been examined are, in the cases of acetic acid and its chloro-derivatives, the heat of fusion, heat capacities both as solids and liquids, heat of dissolution, heat of dilution, and freezing points when mixed with water; the boiling points, densities, and magnetic rotations are also compared with these. In the case of the bromo-derivatives, the heat of dissolution of the solids alone was determined.

As regards the boiling point, heat capacity of liquid, density and heat of dissolution, acetic acid appears to occupy an exceptional position when compared with its chloro-derivatives, whereas, as regards the freezing point. magnetic rotation, and heat of dilution, the alternate members of the series show a close relationship with each other.

Monochloracetic acid was found to exist in four distinct crystalline modifications, differing from each other in their melting points by about 5°. Any of these modifications can be obtained at will, either from the liquid acid or from mixtures of it with water. The most stable form (the α) possesses a heat of fusion, and, hence, a heat of dissolution, when solid, about 500 cal. greater (negatively) than that of the β-modification; and from the fact that the heat absorbed on dissolution appears to be exceptionally large when compared with that absorbed by the other chlorinated acids, it is probable that these are in a form comparable with one of the less stable modifications of chloracetic acid. A similar exceptional position is occupied by monobromacetic acid amongst its congeners, but all attempts to obtain other modifications of this acid failed.

76. "$\beta\beta$-Dinaphthyl and its quinones." By F. D. Chattaway, B.A.

Although several substances of the composition $C_{20}H_{14}$, differing considerably in melting point and physical properties, have been prepared, the constitution of only one of these, $\alpha\alpha$-dinaphthyl, is known.

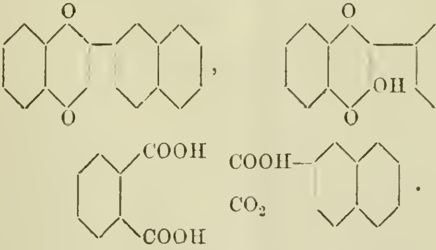
The present paper contains an account of the synthesis of $\beta\beta$-dinaphthyl, of its quinones, and of some closely-related derivatives.

$\beta\beta$-Dinaphthyl is obtained by the action of sodium on β-chloronaphthalene dissolved in boiling xylene in presence of a small quantity of ethyl acetate. It is also produced when zinc dust acts on β-diazonaphthalene sulphate dissolved in alcohol. It crystallises well and completely from benzene or xylene in large, colourless plates, having a slight blue fluorescence. It is easily soluble in boiling benzene, xylene, and glacial acetic acid, much less soluble in alcohol. It sublimes readily, but is not volatile with steam. It melts at 183·5° and boils at 452° under a pressure of 753 mm. Its molecular weight, determined by the depression of the freezing point of a benzene solution, agrees very closely with the calculated number.

When dissolved in glacial acetic acid and oxidised by chromic acid, one or other of two quinones can be obtained, according to the conditions under which the oxidation is performed. If the oxidation be effected rapidly in boiling glacial acetic acid, a quinone is produced in almost theoretical quantities, whose composition and molecular weight agree with the formula $C_{20}H_{12}O_2$. This is an orange-yellow substance, melting at 177° and crystallising in very small needles, generally aggregated into rosettes. It is easily soluble in alcohol, ethyl acetate, glacial acetic acid, and benzene. It yields a colourless hydroquinone on reduction, and dissolves easily in cold concentrated sulphuric acid with a very characteristic, indigo-blue colour. Its appearance and behaviour lead to the conclusion that it is a paraquinone analogous to α-naphthoquinone (1 . 4), having the constitution $C_{10}H_5O{\cdot}C_{10}H_7{\cdot}O$ (1 . 2 . 4).

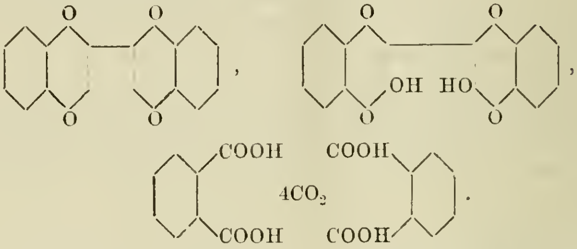
When this quinone is heated with a solution of potassium hydroxide, one of its hydrogen atoms is displaced, the hydrogen liberated reducing the quinone, $C_{20}H_{12}O_2 + KOH = C_{20}H_{11}(OH)_2OK$. If this action takes place in presence of air, the two hydroxyl groups are at once oxidised, the potassium derivative, $C_{20}H_{11}O_2(OK)$, of a hydroxyquinone being formed, from which a hydroxyquinone is set free on addition of an acid. It is a light red, crystalline powder, which melts at about 186—187°, readily soluble in alcohol, benzene, glacial acetic acid, and ethyl acetate, and its composition and molecular weight show that it is derived from the quinone by the replacement of a hydrogen atom by a hydroxyl group. This compound, when dissolved in a hot solution of potassium hydroxide and oxidised by a solution of potassium permanganate, yields phthalic acid, carbon dioxide, and β-naphthoic acid.

This seems to show that the quinone is really β-naphthyl naphthoquinone, $C_{10}H_5{\cdot}O{\cdot}C_{10}H_7{\cdot}O$ (1 . 2 . 4), the replacement of hydrogen by hydroxyl and the breaking down of the molecule taking place as follows.



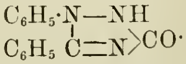
The second quinone, $C_{20}H_{10}O_4$, is produced in small quantity if a considerable excess of chromic acid is used in the oxidation and if the action is prolonged. It can easily be separated from β-naphthylnaphthoquinone by its slight solubility in alcohol. It is probably formed by the further oxidation of the naphthyl naphthoquinone, as it is always accompanied by more or less of that substance and by tarry decomposition products.

The quinone, $C_{20}H_{10}O_4$, is a light brown, somewhat earthy-looking powder, the particles having no definite crystalline shape. It is moderately soluble in boiling glacial acetic acid and benzene, slightly in hot alcohol. It melts at about 216—217°, and gives a deep orange colour with cold concentrated sulphuric acid. It behaves very much like the simpler quinone, its behaviour being modified apparently by its containing two naphthoquinone groups instead of one. When heated with a solution of potassium hydroxide, it is dissolved, forming a dipotassium derivative, the liberated hydrogen, as before, reducing the quinone, $C_{20}H_{10}O_4 + 2KOH = C_{20}H_8(OH)_4(OK)_2$. In presence of air, the hydroxyl groups are oxidised, and, on addition of an acid, a dihydroxydiquinone, of the composition $C_{20}H_8O_4(OH)_2$, is thrown down. This forms a dark red, almost black, powder, which gives a red streak on unglazed porcelain. It melts near 215°, and is easily soluble in glacial acetic acid, ethyl acetate, and alcohol. When dissolved in a boiling solution of potassium hydroxide and oxidised by a solution of potassium permanganate, it yields apparently only phthalic acid and carbon dioxide, which makes it probable that the quinone is ββ-di-α-naphthoquinone, $C_{10}H_5O_2{\cdot}C_{10}H_5O_2$ (1 . 2 . 4 . 1 . 2 . 4), the actions being represented as follows.



77. "Action of benzaldehyde on phenylsemicarbazide." By George Young, Ph.D.

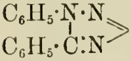
When alcoholic solutions of benzaldehyde and phenylsemicarbazide are evaporated to dryness, reaction occurs according to the equation, $C_7H_9N_3O + C_7H_6O + O = C_{14}H_{11}N_3O + 2H_2O$. The yield is much increased by adding an oxidising agent such as ferric chloride. The product, which has slight basic and decided acid properties, is a diphenyloxytriazol,



$\begin{array}{l}C_6H_5{\cdot}N{-}NH\\C_6H_5\,\overset{|}{C}{=}N\end{array}\!\!>CO\cdot$

The silver salt, $C_{14}H_{10}N_3OAg + H_2O$, and the hydrochloride, $C_{14}H_{11}N_3OHCl + 2H_2O$ have been prepared; the latter is dissociated by water. The acetyl derivative, $C_{14}H_{10}N_3O(C_2H_3O)$ (m. p. 133°) is prepared by the action of acetic anhydride and sodium acetate. The ethylic ether, $C_{14}H_{10}N_3O(C_2H_5)$ (m. p. 92°) is prepared by the action of ethyl iodide on the silver salt or by heating diphenyloxytriazol with potassium hydroxide, ethyl iodide, and ethyl alcohol for an hour in a sealed tube at 100°.

The diphenyloxytriazol is reduced to diphenyltriazol, a weak base,



$\begin{array}{l}C_6H_5{\cdot}N{\cdot}N\\C_6H_5{\cdot}\overset{|}{C}{:}N\end{array}\!\!>CH$, (m. p. 91°) by heating with phosphorus pentasulphide to 230—250°, for six hours; its hydrochloride, $C_{14}H_{11}N_3HCl + 2H_2O$, and its platinichloride, $(C_{14}H_{11}N_3HCl)_2PtCl_4 + 4H_2O$, are both dissociated by water. The latter on being heated to 180° loses besides its water of crystallisation 4 molecular proportions of hydrochloric acid.

78. "Note on the latent heat of fusion." By N. F. Deerr.

If, in Mr. Crompton's relation (Trans., **145**, 240), $Aw/Tv = C$, $1/S$ where S is the specific heat, be substituted for A, we obtain $w/STv = C$, and when the valency is constant, $w/ST = C$.

In order that this relation may have a definite meaning, w/S must be temperature, or, symbolically, $w/S = T'$.

Then $w = ST'$, which, since w is quantity of heat, as is also ST', is a true relation. For the quantity w/S I would propose the term "temperature equivalent of latent heat of fusion," so that Mr. Crompton's relation may be expressed:—"When the valency of any series of elements is the same, the temperature equivalent of the latent heat of fusion bears a constant ratio to the absolute temperature of the melting point."

Denoting the temperature equivalent of the latent heat of fusion by T_f, and temperature of the melting point by T, the table below includes values of T/T_f for all the elements for which w is known; it will appear that there are exceptions to the rule, but that in the majority of cases the agreement is most striking.

Monads.

Elements.	T_f.	T.	T/T_f.
Sodium	111	365	3·32
Potassium	94	335	3·57
Silver	377	1220	3·25
Thallium	167	565	3·35
Bromine	151	266	1·76
Iodine	217	386	1·78

Between the metallic elements considered separately, and also between the non-metallic elements, there is a remarkable agreement; it would not, however, be expected that there would be a law connecting elements with such widely varying properties as, say, bromine and sodium; it is, however, worthy of notice that the value of T/T_f for bromine and iodine is very nearly half that for the metallic monad elements.

Dyads.

Elements.	T_f.	T.	T/T_f.
Zinc	299	695	2·32
Cadmium	252	601	2·38
Mercury	90·5	233	2·58
Palladium	625	1700	2·72
Platinum	875	2050	2·34
Lead	174	603	3·47
Tin	253	503	1·99

Lead and tin are taken as dyads; with the exception of the disagreement shown by these elements, the values of T/T_f are quite satisfactory.

Triads.

Elements.	T_f.	T.	T/T_f.
Gallium	238	286	1·20
Phosphorus	25	317	12·05
Bismuth	434	535	1·23
Gold	510	1328	2·60

The agreement between gallium and bismuth is satisfactory, and gold, although evidently triad, is better included with platinum and palladium: of the abnormal value of phosphorus I can give no explanation; it will be remembered, however, that in Mr. Crompton's relation the reciprocal of the valency was taken.

Tetrads.

Elements.	T_f.	T.	T/T_f.
Sulphur	57·5	385	6·70
Aluminium.......	133	870	6·55

Sulphur is taken as a tetrad, as it appears in the dioxide; the close agreement between sulphur and aluminium, perhaps, justifying this.

79. "Acid compounds of some natural yellow colouring-matters. Part I." By A. G. Perkin and L. Pate.

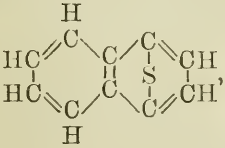
In a previous communication by one of us in conjunction with J. J. Hummel (*Ber.*, **15**, 2337) an account was given of some peculiar acid compounds formed by the action of mineral acids upon hæmatein and brazilein, the colouring matters of logwood and brazilwood. In continuation of this work the behaviour of acids towards various natural yellow colouring matters has been studied, the results of which are embodied in the following table.

	H_2SO_4.	HBr.	HCl.	HI.
Quercetin	$C_{15}H_{10}O_7 \cdot H_2SO_4$	$C_{15}H_{10}O_7HBr$	$C_{15}H_{10}O_7HCl$	$C_{15}H_{10}O_7 \cdot HI$
Rhamnazin ...	$C_{17}H_{14}O_7 \cdot H_2SO_4$	no action	no action	no action
Rhamnetin ...	$C_{16}H_{12}O_7H_2SO_4$	”	”	”
Luteolin	$X \cdot H_2SO_4$	”	”	”
Fisetin	$C_{15}H_{10}O_6H_2SO_4$	$C_{15}H_{10}O_6HBr$	$C_{15}H_{10}O_6HCl$	
Morin	$C_{15}H_8O_6H_2SO_4$	$C_{15}H_{10}O_7HBr$	$C_{15}H_{10}O_7HCl$	$C_{15}H_{10}O_7 \cdot HI$
Catechin	no action	no action	no action	no action
Maceurin	”	”	”	”

These compounds are produced in the form of lustrous orange or scarlet needles, which cannot be recrystallised without decomposition. On treatment with water they are decomposed into the original colouring matter and free acid, and a similar result occurs when the hydrochloric acid compounds are heated for some time to 100°.

As is well-known the colouring matters here studied form two classes, only one of which combine with acids. Of these, fisetin and maceurin may be taken as types. A third class also exists in which are included gentisein, the colouring matter of gentian root (Tambor, *Inaug. Dissert.*, *Leipsig*, 1894) and datiscetin, which is obtained from *Datisca cannabina* (Schunck and Marchlewski, *Annalen*, **277**, 261).

80. "Action of sulphur on α-nitronaphthalene." By A. Herzfelder, Ph.D

When α-nitronaphthalene is heated at about 270° with 25 per cent. of sulphur, vigorous interaction takes place, sulphur dioxide being evolved, whilst a black solid mass remains. From this solid an amorphous green substance was isolated which has the formula, $C_{10}H_6S$, and the molecular weight 158. It dissolves in the same solvents as sulphur, and melts at 155°, with decomposition. It possesses none of the properties of a mercaptan, and gives, on treatment with bromine, αα′-dibromonaphthalene. Its formula is most probably, , and the name αα′-thionaphthalene is proposed for it. The products of bromination, nitration, and sulphonation, have been examined.

List of Periodicals in the Circulating Library.

The following periodicals may be borrowed by Fellows under the usual regulations. Single parts may not be retained more than a week :—

American Chemical Journal. 10 vols. Baltimore, Ind., 1879 + .
American Journal of Science. 3rd Series. Vol. XXVII. 1884 +
Analyst. 13 vols. 1876 + .
Annalen (Liebig's). 282 vols. 1832 + .
  Supplements 1, 1861; 2, 1862–63; 3, 1864–65; 4, 1865–66; 5, 1867; 6, 1868; 7, 1870; 8, 1872. Register 1—164, 1874; 165—220, 1885.

Annalen der Physik und Chemie. Herausgegeben von Julius C. Poggendorff. 30 vols. Berlin 1824–33. Zweite Reihe. 30 vols. 1834–43. Dritte Reihe. 30 vols. 1844–53. Vierte Reihe. 30 vols. 1854–63. Fünfte Reihe. 30 vols. 1864–73. Sechste Reihe. 10 vols. 1874–77. Neue Folge. 52 vols. 1877 + .

Ergänzungs-Bände: Bd. I, 1843; II, 1848; III, 1853; IV, 1854; V. 1871; VI, 1874; VII, 1876; VIII, 1878. Jubelband 1874. Namen Register zu Bd. 1–150, und Sach-Register zu Bd. 121—150. Leipzig 1875.

Beiblatter zu den Annalen der Physik und Chemie. Herausgegeben unter Mitwirkung befreundeter Physiker von J. C. Poggendorff. 17 vols. Leigzig 1878 + .

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I. *Donations.*

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NOTICE.

In accordance with notice given at the Ordinary Meeting on June 6th, an Extraordinary General Meeting of the Society will be held on Thursday, June 20th, at 8 P.M., to consider the following change in the Bye-laws proposed by the Council :—

In Bye-law 1 to strike out the last paragraph, beginning "The life composition fee," and to insert the following :—

"The life composition fee shall be Thirty Pounds, excepting that Fellows who have paid ten annual subscriptions shall pay as life composition fee Twenty Pounds; Fellows who have paid fifteen annual subscriptions shall pay Fifteen Pounds; Fellows who have paid twenty annual subscriptions shall pay Twelve Pounds; and Fellows who have paid twenty-five annual subscriptions shall pay ten pounds."

The business of the Ordinary Meeting will be taken as soon as that of the General Meeting has been completed. There will be a ballot for the election of Fellows, and the following papers will be read :—

"On Lintner's isomaltose." By Horace T. Brown, F.R.S., and G. H. Morris, Ph.D.

"Transformation of ammonium cyanate into urea." By Professor Walker, D.Sc., and J. F. Hamley.

"Some derivatives of humulene." By A. C. Chapman.

"Note on thio-derivatives of sulphanilic acid." By Miss Walter.

"The chlorination of orthochlorotoluene." By W. P. Wynne, D.Sc., and A. Greaves.

"The six dichlorotoluenes." By W. P. Wynne, D.Sc., and A. Greaves.

"The disulphonic acids of toluene and of ortho- and para-chlorotoluene." By W. P. Wynne, D.Sc., and J. Bruce.

"Ethereal salts of ethanetetracarboxylic acid." By Professor Walker, D.Sc., and J. R. Appleyard.

"On helium." By Professor Ramsay, F.R.S.

"A method for preparing formyl derivatives of aromatic amines." By H. R. Hirst and J. B. Cohen, Ph.D.

"A modification of Zincke's reaction." By H. R. Hurst and J. B. Cohen, Ph.D.

"A new method of preparing cyanuric acid." By W. H. Archdeacon, B.Sc., and J. B. Cohen, Ph.D.

CERTIFICATES OF CANDIDATES FOR ELECTION AT THE NEXT BALLOT.

N.B.—The names of those who sign from "General Knowledge" are printed in *italics.*

The following Candidates will be balloted for on Thursday, June 20th, 1895:—

Croysdale, John,

The Grange, Whitley Bridge, R.S.O.

Chemist in the laboratory of Sulphuric Acid and Artificial Manure Works of Messrs. Croysdale and Son, Whitley Bridge, near Pontefract. Educated at Wakefield Grammar School. Pupil for three years in the laboratory of Mr. Fairley, of Leeds. Two to three years in charge of laboratory at works.

Thomas Fairley. Jas. Baynes.
B. A. Burrell. *Wyndham R. Dunstan.*
Geo. Ward. *Sydney J. Harris.*
Bernard Dyer.

Lones, Joseph,

Lansdowne, South Road, Smethwick.

Analytical Chemist. I have served five years in a private laboratory, and gone through a three years' scientific training at Mason College, Birmingham. Taught Iron and Steel Metallurgy under the Smethwick Technical School, and am a Fellow of the Institute of Chemistry.

William A. Tilden. W. W. J. Nicol.
Percy F. Frankland. C. F. Baker.
D. R. Boyd. Walter G. McMillan.

Morison, James,

7, O'Connell Street, Sydney, N.S.W.

Analytical Chemist. Three years Assistant with Messrs. McCowan and Biggart, Public Analysts, Greenock; studied two years at G. and W. of Scotland Technical College, Glasgow, under Professors

Dittmar, Henderson, and E. J. Mills; became Assistant to Professor Mills, D.Sc., F.R.S.; and now Chemist with the Colonial Sugar Refining Company (Limited), Sydney, N.S.W.

Edmund J. Mills. James Robson.
Thomas Gray. G. G. Henderson.
Aug. Schloesser.'

Read, Edwin James,

2, Leigh Terrace, Ampthill Road, Bedford.

Analyst. B.A., Honours, Natural Science Tripos, Cambridge. A Student of Chemistry for three years at the Cambridge University and Sidney Sussex College Laboratories, and since then engaged as Assistant to Dr. Muter, South London Central Public Laboratory.

John Muter. L. de Koningh.
H. J. H. Fenton. Robert Steele.
A. J. Greenaway.

Simons, Albert Joseph,

Elmhurst, New Barnet, Herts.

Analytical Chemist to Messrs. Thos. Tyrer and Co., Stirling Works, Stratford. Has studied Practical Chemistry under Professor Attfield for two years; has attended a full course of lectures on Inorganic, Physical, and Organic Chemistry under Professor Dunstan; has studied for 12 months in the Research Laboratory of the Pharmaceutical Society the principal methods used in Chemical Investigations, and has assisted in an enquiry on the Nitro-compounds of the Paraffin Series; has held for three and a half years the appointment of Chemist to Messrs. Tyrer and Co., of Stratford.

Thos. Tyrer. Wyndham R. Dunstan.
John Attfield. Chas. Umney.
John C. Umney.

Proposed by the Council under Bye-law I (3).

Potter, Arthur E., M.A. (Camb.), B.Sc. (Lond.),

Rangoon, Burmah.

Inspector of Schools, Western Circle, Burmah. Science Scholar and Science Prizeman, Christ College, Cambridge. Honours in Natural Science Tripos. Honours in Chemistry at Intermediate B.Sc., London. Associate of the Yorkshire College, Leeds.

T. E. Thorpe.

HARRISON AND SONS, PRINTERS IN ORDINARY TO HER MAJESTY, ST. MARTIN'S LANE.

Issued 16/7/1895.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

EDITED BY THE SECRETARIES.

No. 154. Session 1894–95.

June 20th, 1895. Mr. A. G. Vernon Harcourt, President, in the Chair.

Extraordinary General Meeting. The following change in the Bye-laws was proposed from the Chair, and passed.

In Bye-law 1, the last paragraph, beginning "The life composition fee," was struck out and the following inserted:—

"The life composition fee shall be Thirty Pounds, excepting that Fellows who have paid ten annual subscriptions shall pay as life composition fee Twenty Pounds; Fellows who have paid fifteen annual subscriptions shall pay Fifteen Pounds; Fellows who have paid twenty annual subscriptions shall pay Twelve Pounds; and Fellows who have paid twenty-five annual subscriptions shall pay ten pounds."

At the ordinary Scientific Meeting which followed, Messrs. George J. Ward, John Wilson, E. S. Barralet and W. A. Greaves were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Edward Henry Farr, Uckfield; Edward Henry Grossman, 12, Alfred Place West, S.W.; C. E. Harrison, 53, Lansdowne Road. W.

The following were duly elected Fellows of the Society.

John Croysdale, Joseph Lones, James Morison, Arthur E. Potter, M.A., B.Sc., Edwin James Read, B.A., Albert Joseph Simons.

Of the following papers those marked * were read.

*81. "On the 'isomaltose' of C. J. Lintner." By Horace T. Brown, F.R.S., and G. Harris Morris, Ph.D.

The paper gives a detailed account of the authors' investigations into the nature of Lintner's "isomaltose," and their results are summed up in the following conclusions:—

1. When the products of a starch-transformation by diastase are submitted to any known process of fractionation, the properties of each and every fraction strictly conform to the "law of definite relation" of opticity and reducing power.

2. The "isomaltose" of C. J. Lintner is not a chemical entity, but can be further split up by careful fractionation with alcohol and by fermentation, in such a manner as to indicate that it is a mixture of *maltose* and dextrinous substances of the malto-dextrin or amyloïn class. We must therefore cease to use this term "isomaltose" in relation to any of the products of the diastatic conversion of starch.

3. The crystallisable osazone which Lintner has described as "isomaltosazone," and upon which he has mainly founded his belief in the existence of "isomaltose" is nothing but "maltosazone" modified in its crystalline habit and melting point by the presence of small but variable quantities of another substance.

4. The substance or substances which are capable of thus modifying maltosazone are the products of the action of phenylhydrazine on the dextrinous substances mentioned in 2.

5. This can be shown (1) *analytically*, by careful fractionation of the starch-products by alcohol, and also by fermentation; and (2) *synthetically*, by the recrystallisation of pure maltosazone in the presence of the non-crystallisable products of the action of phenylhydrazine on the maltodextrins

6. The only substance amongst the products of starch-transformation by diastase which is capable of yielding a crystallisable osazone, is *maltose*.

7. The results of the investigation bring out very clearly the danger of attempting to identify the carbohydrates in mixtures solely by the properties of their osazones, as these properties are liable to considerable modification by other substances of the same class which may not in themselves be crystallisable or readily separable from aqueous solutions.

DISCUSSION.

Mr. ARTHUR R. LING claimed priority on behalf of himself and Mr. J. L. Baker in having pointed out that Lintner's so-called isomaltose is not a homogeneous compound (Proc., 1895, 3). In this communication they had also adduced strong evidence in favour of the view that the so-called isomaltose is a mixture of maltose, and the simple dextrin, $C_{12}H_{20}O_{10}$, and they had proved that the osazone melting at 150—152° has the composition of a hexatriosazone.

82. "Action of diastase on starch: nature of Lintner's isomaltose." By Arthur R. Ling, and Julian L. Baker.

In a previous communication (Proc., 1895, No. 146, 3), the authors have described the isolation of a substance from the transformation products of starch by the diastase prepared from low-dried or green malt. This substance had approximately the optical and cupric reducing powers of Lintner's so-called isomaltose. Analyses and cryoscopic determinations made with this substance indicated that it had the molecular formula $C_{12}H_{22}O_{11}$; but the essential difference between it and the so-called isomaltose of Lintner was that it yielded maltosazone together with a very small quantity of an osazone melting at 145—152° on treatment with phenylhydrazine acetate, whereas Lintner states that his compound yields a single characteristic osazone melting at 150—152°. The authors have examined the low melting osazone obtained from their product, and conclude that it is merely impure maltosazone. More recent experiments carried out by the authors support their view that Lintner's so-called isomaltose consists of a mixture of maltose and the simple dextrin, $C_{12}H_{20}O_{10}$ (*loc. cit.*). No glucose is present among the products of the action of diastase from low-dried malt on starch, and diastase from this source is without action on maltose.

It was previously shown (*loc. cit.*) that when starch is transformed at 70° with the diastase prepared from kiln-dried or brewer's malt, the fraction which should correspond with Lintner's isomaltose gives, on treatment with phenylhydrazine acetate, glucosazone together with an osazone agreeing in crystalline appearance and melting point with the so-called isomaltosazone of Lintner, but having the composition $C_{18}H_{30}O_{14}(N_2HPh)_2$, as if derived from a *hexatriose*, $C_{18}H_{32}O_{16}$. A diligent search has therefore been made for this triose among the transformation products last mentioned, but no crystalline compound has been isolated from them with the exception of maltose. Glucose was invariably present in small amount, and the authors find that when maltose is treated at 70° for two hours with the diastase prepared from high-dried malt, the presence of about 20 per cent. of glucose is indicated by the increased cupric reducing power and the diminished optical activity; glucose was also detected qualitatively by the production of glucosazone. Bearing in mind the presence of glucose, as also their suggestion that Lintner's isomaltose contains the simple dextrin, it occurred to the authors that the triosazone was possibly produced by the interaction of this dextrin and glucose with phenylhydrazine, and this turns out to be the case. When the supposed isomaltose is treated with phenylhydrazine acetate in presence of glucose, the portion of the product soluble in hot water consists of a mixture of the triosazone and maltosazone.

*83. "The transformation of ammonium cyanate into urea." By James Walker, D.Sc., Ph.D., and F. J. Hambly.

The transformation of ammonium cyanate into urea is reversible, about 5 per cent. of urea in decinormal aqueous solution at 100° being retransformed into ammonium cyanate. The direct transformation obeys the laws of a bimolecular reaction, and not of a unimolecular reaction, as might be expected. This is accounted for by the assumption that the ammonium cyanate is largely dissociated into ammonium ions and cyanic ions, and this assumption is confirmed by the influence of ammonium sulphate, potassium sulphate, potassium cyanate, and other substances, on the rate of the reaction. The dissociation theory also enables us to calculate the quantitative phenomena taking place when the transformation of urea into ammonium cyanate occurs in presence of silver nitrate. The speed of the reaction varies greatly with the temperature, and the variation may be expressed by means of van't Hoff's formula.

*84. "Note on the transformation of ammonium cyanate into urea." By H. J. H. Fenton, M.A.

Some years ago the author made a short communication to the Cambridge Philosophical Society upon this subject. (The metameric transformation of ammonium cyanate, *Proc. Camb. Phil. Soc.*, 1888, 307.) Details of these experiments were not published as it was intended to make further experiments. The reason for giving these details in the present note is that, in the list of papers to be read at the present meeting there is one which has the above title, and it was thought that the observations might be of interest to the authors. Unfortunately the Proceedings of the Cambridge Philosophical Society are not often seen by chemists outside Cambridge, so that it is hardly to be expected that these authors should be aware of this communication.

In a previous paper (Trans., 1878) I showed that urea when treated with sodium hypochlorite in presence of caustic soda in the cold, evolves only one-half of its nitrogen in the free state, the remainder being retained in form of cyanate. The latter gives no nitrogen with hypochlorite or hypobromite.

Ammonium cyanate was prepared by direct union of cyanic acid vapour and dry ammonia. Weighed portions of this salt were acted upon by sodium hypobromite and hypochlorite and excess of soda with the following results. With sodium hypobromite.

I. 0·0544 gram AmCyO gave 9·3 c.c. nitrogen (corr.).
II. 0·0562 ,, ,, ,, 9·93 c.c. ,,

Since with hypobromite estimations, as conducted in the usual way, there is a deficiency of about 8 per cent. in the nitrogen evolved, a correction for this was applied giving (I) 10·10 c.c., and (II) 10·79 c.c. Theory for *half* the nitrogen requires 10·11 c.c. and 10·45 c.c. respectively.

With sodium hypochlorite.

	Theory for $\frac{1}{2}N_2$.
0·0620 gram AmCyO gave 11·89 c.c. nitrogen (corr.).	11·53
0·0692 ,, ,, ,, 13·08 ,, ,,	12·87
0·0905 ,, ,, ,, 16·34 ,, ,,	16·83

It is evident, therefore, that this salt evolves only half its nitrogen in the free state with either reagent.

These facts obviously suggest a method by which it is possible to estimate the extent to which ammonium cyanate has been transformed into urea.

Let V = volume of nitrogen obtained by the action of hypobromite when a given weight of ammonium cyanate is taken and partly or entirely converted into urea; and let V_1 = total volume of nitrogen contained in the substance taken. Then the nitrogen due to the urea formed will be $2V - V_1$. For convenience the percentage transformation may be expressed as $2V - V_1/V_1 \times 100$.

Applying this method, the following results were obtained.

0·7632 gram AmCyO was dissolved in water and the solution made up to 100 c.c. 10 c.c. were taken for each experiment.

	Temp.	Time.	Vol. of N_2 (corr.).	Theory for $\frac{1}{2}N_2$.	Transformation.
I.....	Ordinary (about 19°)	immediate	14·14	14·19	none
II.....	37°	18 hours	19·0	—	33·8
III.....	37°	3 days	20·54	—	44·7

0·5561 gram AmCyO dissolved in water and made up to 100 c.c. 10 c.c. taken.

I.....	Ordinary	20 hours	12·60	10·34	20·3
II.....	—	—	12·28	—	—
III.....	100°	1 hour	17·57	—	69·9
IV.....	100°	$2\frac{1}{2}$ hours	19·03	—	84·0
V.....	100°	20 hours	19·50	—	88·5

0·9495 AmCyO in 100 c.c. 10 c.c. taken.

I.....	70°	1 hour	25·9	17·66	46·6
II.....	70°	4 hours	28·5	—	61·3
III.....	70°	40 hours	30·4	—	72·1

In each case the liquid was measured into a small, partly drawn off test-tube which was afterwards sealed. A correction for the loss of 8 per cent. is made in the stated volumes of nitrogen.

These results indicate that the change proceeds rapidly at first, then becomes slower, and finally reaches a limit which is a function of the temperature. In no case examined was the transformation complete.

These facts suggest that the action may be a reversible one; urea and ammonium cyanate are perhaps tautomeric forms transformable one into the other. This hypothesis would account for some of the properties of urea which are otherwise difficult to understand. For example, the difference in the actions of hypobromite and hypochlorite (in presence of soda), mentioned above, might be explained in the following way. The action of hypobromite is nearly instantaneous, whereas that of hypochlorite is extremely slow. The solution of urea may contain urea and ammonium cyanate in a state of equilibrium, the urea, of course, largely preponderating. Hypobromite therefore evolves nearly all the nitrogen—all from the urea, and half from the ammonium cyanate. Hypochlorite, however, it may be supposed attacks only the ammonium cyanate liberating half of its nitrogen, the other half remaining as cyanate which is not further decomposed. This would destroy the equilibrium of the system, and a further transformation of urea into ammonium cyanate would result. The latter would be removed as before, and finally one-half of the total nitrogen would be evolved in the free state.

There are indications also that cyanate is produced when urea solution mixed with potash in excess is left to stand for several weeks in a bell-jar over sulphuric acid. This fact could be explained in a similar manner.

*85. "Some derivatives of humulene." By Alfred C. Chapman.

In a former communication (Trans., 1895, **67**, 54) the author described a sesquiterpene obtained from the essential oil of hops by fractional distillation; for which he suggested the name humulene. In that paper a nitrosochloride (m. p. 164—165°) was described, and also a nitrol-piperide obtained from it (m. p. 153°).

In the present paper the author gives an account of the following additional humulene derivatives.

Hydrochloride of humulene nitrol-piperide ($C_{15}H_{24}NO{\cdot}NC_5H_{10}{\cdot}HCl$). This was obtained by passing dry hydrogen chloride into a solution of the nitrol-piperide in ether. The platinichloride of this salt crystallising from alcohol in reddish needles was also prepared (m. p. 187—189°).

Humulene nitrol-benzylamine ($C_{15}H_{24}NO \cdot NHCH_2C_6H_5$).—This compound was obtained by heating humulene nitrosochloride with an excess of benzylamine. After crystallisation from boiling alcohol it melted at 136°. The hydrochloride of this base was prepared by passing hydrogen chloride into an ethereal solution of the compound (m. p. 187—189°).

Humulene nitrosate ($C_{15}H_{22}N_2O_4$).—Prepared by acting with nitric acid upon a mixture of humulene and amylnitrite in glacial acetic acid. It crystallises from benzene in small colourless needles melting at 162—163°.

Humulene nitrosite ($C_{15}H_{24}N_2O_3$).—This compound was prepared by allowing nitrous anhydride to combine with humulene dissolved in petroleum ether. After one recrystallisation from boiling alcohol the compound was obtained in the form of magnificent deep blue needles, melting at about 120°. The mother liquor from which this compound separated deposited colourless needles which, after recrystallisation, melted at 166—168°, and were found to be isomeric with the blue compound. This latter could be almost completely converted into the white substance by the long-continued boiling of its alcoholic solution.

*86. " Note on thio-derivatives from sulphanilic acid." By L. Edna Walter.

When diazotised sulphanilic acid and potassium xanthate are allowed to interact, following Leuckart's directions (*J. pr. Chem.*, 1890, **41**, 179), the parasulphonate-xanthate of the formula $SO_3K \cdot C_6H_4 \cdot S \cdot CS \cdot OEt$ is readily formed as an easily soluble crystalline salt. On hydrolysis this xanthate undergoes change in two ways and yields both the sulphydride, $SO_3K \cdot C_6H_4 \cdot SH$, and the sulphethide, $SO_3K \cdot C_6H_4 \cdot SEt$. As the former, however, is very readily oxidised, the corresponding disulphide is usually obtained. When acid is used in effecting hydrolysis, the disulphide is the only product, but when alkali is used the product is a mixture which apparently is the richer in sulphethide the more concentrated the alkali.

When the dried xanthate is heated at about 200°, it loses considerably in weight, being converted into the sulphethide, which is more easily prepared in this way; only a small amount of disulphide is produced in this case.

The potassium disulphide crystallises in needles; it is very soluble in water and sparingly soluble in alcohol. It yields a crystalline sulphochloride melting at 142°, and a sulphonamide melting at 253°.

The potassium sulphethide is very soluble in water and in alcohol; it crystallises in six-sided plates. The barium salt crystallises in very characteristic rhombic plates; its sulphochloride melts at 33°, and its sulphonamide at 134°.

The sulphethide is converted by oxidation with permanganate into the corresponding sulphonate which is soluble in water, and yields a sulphochloride melting at 103·5°.

The sulphide, on the other hand, very readily yields benzeneparadisulphonate when oxidised by permanganate. The xanthate may also be directly converted into paradisulphonate by oxidation with permanganate, and it is easy in this manner to prepare any desired quantity of benzeneparadisulphonic acid.

One disulphochloride, $C_6H_4(SO_2Cl)_2$, prepared from the product, fuses at 136·5°, several degrees higher than the melting point assigned by Körner and Monselise.

*87. "Helium, a constituent of certain minerals. Part II." By William Ramsay, F.R.S., J. Norman Collie, Ph.D., and Morris Travers, B.Sc.

The first part of this communication contains an account of the sources of helium. About 30 minerals have been investigated, mainly those containing uranium, and of these, 15 contained helium in greater or less amount. Many, in addition, evolved hydrogen, a hydrocarbon, and carbon dioxide.

The second part treats of the densities of samples from different sources. After purification, the value 2·2 was obtained for three samples, one from clèveite, one from bröggerite heated alone, and one from bröggerite fused with hydrogen potassium sulphate. It was proved during these experiments that hydrogen is not evolved in combination with helium by the action of acid on mineral containing helium. The density of all these samples, united and carefully purified, was 2·218; a second purification made the density 2·228, practically an identical number.

The wave-length of sound in the gas corresponds accurately to the ratio $1 : 1\frac{2}{3}$, implying monatomicity, if that be granted to mercury on the same and on different grounds. The atomic weight would therefore be 4·4.

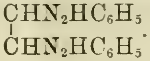
The solubility in water is 0·007 at 18°. Helium is therefore the least soluble of gases. It is insoluble in alcohol and in benzene.

The paper concludes with a discussion of the relations of helium towards other elements.

88. "New formation of glycollic aldehyde." By H. J. H Fenton, M.A.

The properties of the acid $C_4H_4O_6{\cdot}2H_2O$, which was described by the author in a previous paper (Trans., 1894), are still being investigated with a view of establishing the constitutional formula for the acid. The present paper deals with the decomposition which the acid undergoes when heated with water. It is shown that, under these circumstances, glycollic aldehyde and carbon dioxide are produced, the change taking place almost quantitatively according to the equation $C_4H_4O_6 = C_2H_4O_2 + 2CO_2$.

The glycollic aldehyhe was identified by oxidation to glycollic acid and by the action of excess of phenylhydrazine acetate which gave the phenylosazone of glyoxal,



$\begin{array}{l}CHN_2HC_6H_5\\ \mid\\ CHN_2HC_6H_5\end{array}$.

This decomposition affords a very simple method for the preparation of glycollic aldehyde.

By spontaneous evaporation of the aqueous solution (and purification from a trace of glyoxylic acid produced) the aldehyde was obtained in an isolated condition as a viscid syrup, pure, except for a trace of ether or alcohol, which is obstinately retained. On removing this ether by heating under reduced pressure the aldehyde undergoes polymerisation, a sweet-tasting solid gum being the result. Molecular weight determinations indicate that this substance is a form of hexose, $C_6H_{12}O_6$. It reduces Fehling's solution in the cold, and gives an osazone melting at 162—163°.

89. "Ethereal salts of ethanetetracarboxylic acid." By James Walker, Ph.D., D.Sc., and J. R. Appleyard.

Symmetrical dimethylic dihydrogen ethanetetracarboxylate should, according to stereochemical theory, exist in an inactive and a racemic modification, and the corresponding potassium salts should yield on electrolysis dimethylic maleate and dimethylic fumarate respectively. An attempt was made to separate the two modifications, but it was unsuccessful. The mixed dimethyl dipotassium salts on electrolysis gave a small quantity of dimethylic fumarate. The following derivatives of *ethanetetracarboxylic acid* were prepared in the investigation. *Tetramethylic salt*, m. p. 104°, symmetrical. *Dihydrogen dimethylic salt*, m. p. 158—160° with decomposition. *Triethylic monomethylic salt*, m. p. 58°. *Diethylic dimethylic salt*, liquid.

90. "On the occurrence of argon in the gases enclosed in rock salt." By P. Phillips Bedson, M.A., D.Sc., and Saville Shaw.

The brine obtained from the wells sunk in the rock salt deposit on the north bank of the Tees, in the neighbourhood of Middlesbrough, when pumped to the surface is found to be strongly effervescent The gas, the liberation of which gives rise to this phenomenon, had been analysed by one of us some years ago (*J. Soc. Chem. Ind.*, 1888, 660—667), and found to consist of

	By volume.
Methane	2·05
Nitrogen	97·95
	100·00

It was thought that a re-examination of this gas with a view of testing its freedom or otherwise from argon would be of interest. Through the kindness of Mr. Alfred Allhusen, a fresh sample was accordingly procured in May of the present year, when it was found to have slightly altered in composition and to contain

	By volume.
Oxygen	1·3
Nitrogen	98·7
	100·0

only a minute quantity of methane being present, and the small amount of oxygen probably due to air leakage.

Professor Ramsay kindly furnished details of the simplest method for ascertaining the presence of argon in the gas—"sparking" over caustic soda in presence of oxygen, and submitting the residue after contraction ceased to spectroscopic examination. A small induction coil, giving a ¾-in. spark in air and actuated by the current from a battery of storage cells, was employed. About 40 c.c. of the gas was submitted to examination in each experiment. The sparking was continued in presence of an excess of oxygen until no further contraction was noticeable. After this it was found necessary to continue the sparking for an hour or two, until examined spectroscopically the nitrogen lines, which grew fainter and fainter, finally disappeared. After absorbing the excess of oxygen present with alkaline pyrogallate, the small residue was added to an already measured volume of pure oxygen, and the whole accurately measured, using the apparatus of Professor Dittmar in conjunction with a form of Lunge volumeter.

Two estimations gave results as follows

$$\left.\begin{array}{r}\text{I. } 1{\cdot}205\\ \text{II. } 1{\cdot}269\end{array}\right\}\text{Mean} = 1{\cdot}24 \text{ per cent. of argon.}$$

The amount of argon present in the nitrogen from the rock salt is thus practically identical with the amount present in the nitrogen of ordinary air as determined by Lord Rayleigh and Professor Ramsay. This is to the authors' knowledge the first recorded analysis of a sample of naturally occurring nitrogen which has been stored up for some thousands of years under conditions which practically preclude the possibility of change. The nitrogen was probably in the first instance derived from the atmosphere, and it is of considerable interest to note that atmospheric nitrogen at the present day is still associated with the same percentage of argon as when in remote ages it was first occluded in cavities in the rock salt.

As Professor Ramsay has shown that argon is soluble to a considerable extent in water, it is proposed to examine the gas given off on boiling the brine after effervescence has subsided. In this way a gas would probably be obtained much richer in argon, and as there would be little difficulty in procuring it in quantity it might prove a useful source of the new gas. It is also proposed to submit the nitrogen found enclosed in coal to a similar examination.

91. "On the dissociation of gold chloride." By T. K. Rose. D.Sc., A.R.S.M.

The tensions of dissociation of trichloride of gold at various temperatures up to 332° were measured, the limited chemical action investigated being expressed by the equation

$$AuCl_3 \rightleftarrows AuCl + Cl_2.$$

The total pressures observed when a mixture of $AuCl_3$ and AuCl is heated in a closed space are higher than the tensions of dissociation, owing to the vapour pressure of $AuCl_3$, which becomes considerable between 200° and 300°. The attainment of the maximum pressure is greatly delayed if the substances are carefully dried.

An investigation by means of Deville's "hot and cold tubes" showed that $AuCl_3$ undergoes continuous volatilisation in chlorine gas at atmospheric pressure at all temperatures between 180° and 1100°, the limits of temperature employed. The curve illustrating the rate of volatilisation under these conditions passes through a maximum at about 300°, and a minimum between 800° and 900°. Reasons for the shape of the curve are adduced.

The results afford evidence that Krüss's statements on the decomposition and volatilisation of gold chloride cannot be substantiated, but that those of Boyle and of Debray are in accordance with fact. It is pointed out that, according to the laws of chemical equilibrium, compounds formed with evolution of heat cannot be included in the class of bodies which are completely decomposed at moderate temperatures and again formed at much higher temperatures. The statements of Krüss regarding the behaviour of gold chloride at various temperatures, and those of Langer and V. Meyer regarding platinum chloride are therefore at variance with theory, and in the former case have been shown to be unfounded.

92. "On some physical properties of the chlorides of gold." By T. K. Rose, D.Sc., A.R.S.M.

The melting point of trichloride of gold is found to be 288° C., under a pressure of about two atmospheres of chlorine. Its density is 4·3, and that of the monochloride, 7·4. These determinations tend to show that the atomic volume of chlorine when in combination with gold is 4 × 5·1, instead of 3 × 5·1, the volume assigned to it by

Schröder in the case of some of its other compounds. Mr. W. J. Pope found that volatilised crystals of trichloride of gold are crystalline aggregates, but that they cannot be referred to any system as they do not transmit the light from a sodium flame.

93. "The dissociation of liquid nitrogen peroxide. Part II. The influence of the solvent." By J. Tudor Cundall.

The author measures colorimetrically the dissociation at different temperatures of solutions of nitrogen peroxide in 14 "indifferent" solvents, viz.:—Chloroform, ethylene chloride, ethylidene chloride, methylene chloride, carbon tetrachloride, benzene, monochlorobenzene, monobromobenzene, ethyl bromide, ethylene bromide, bromoform, silicon tetrachloride, carbon disulphide, and acetic acid. He finds that the dissociation takes place in the same way, though to a different extent, in the various solvents; the extent of dissociation at any temperature being in the main an additive property, though probably modified by constitution. Thus the carbon atoms in a compound have very little influence on the dissociation power; those of hydrogen have more; then those of bromine and chlorine, whilst those of sulphur and silicon have most. Ethylene chloride is not so effective as ethylidene chloride.

The author compares his results with those of Mentschutkin (*Zeit. Phys. Chem.*, **1**, 611, and **6**, 41), and brings evidence to show that, if the heat of dissociation of liquid nitrogen peroxide is the same as that calculated by van't Hoff for the gas, any reaction that may take place between the dissolved substance and "indifferent" solvent is probably not exothermic.

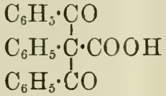
94. "Condensation of benzil with ethylic acetoacetate." By Francis R. Japp, F.R.S., and G. Druce Lander, B.Sc.

By heating a mixture of benzil and ethylic acetoacetate with sodium ethoxide in alcoholic solution, the two first-mentioned compounds condense according to the equation $2C_{14}H_{10}O_2 + C_6H_{10}O_3 = C_{34}H_{28}O_6 + H_2O$. This condensation product is obtained as a sodium compound containing alcohol of crystallisation: $C_{34}H_{27}NaO_6,C_2H_6O$. Acetic acid liberates from this compound *ethylic anhydrodibenzilacetoacetate*, $C_{34}H_{28}O_6$, which crystallises from alcohol or from a mixture of ethylic acetate and light petroleum in flat needles or prisms, with bevelled edges, melting with decomposition at 210°—211°. Although this compound contains the carbethoxyl group, it was not found possible to hydrolyse it to the corresponding acid, owing to the ease with which it is decomposed with regeneration of benzil.

By boiling this compound with alcohol containing a little sulphuric acid *ethylic ethylanhydrodibenzilacetoacetate*, $C_{34}H_{27}(C_2H_5)O_6$, was obtained, which was deposited from alcohol in slender prisms melting at 197°. It was readily hydrolysed by caustic potash. *Ethylanhydrodibenzilacetoacetic acid*, $C_{32}H_{23}(C_2H_5)O_6$, is deposited from benzene in microscopic matted needles melting at 216°. It is isomeric with the condensation compound.

Substituting isobutylic for ethylic alcohol in the foregoing etherification, *ethylic isobutylanhydrodibenzilacetoacetate*, $C_{34}H_{27}(C_4H_9)O_6$, was obtained. It crystallised from a mixture of benzene and light petroleum in minute needles, melting at 202°. On hydrolysis it yielded *isobutylanhydrodibenzilacetoacetic acid*, $C_{32}H_{23}(C_4H_9)O_6$, which was deposited from a benzene solution in slender needles melting at 237°.

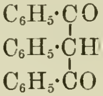
When the condensation compound was oxidised with chromium trioxide in acetic acid solution it yielded a monobasic acid, $C_{22}H_{16}O_4$, which crystallised from a mixture of ethylic acetate and light petroleum in needles melting at 200° with evolution of carbon dioxide. In this process of decomposition by heat the acid is converted into a compound $C_{21}H_{16}O_2$, which is deposited from alcohol in needles melting at 119—120°. The constitution of these two compounds may possibly be expressed by the formulæ



$$\begin{array}{l} C_6H_5\cdot CO \\ \quad\;\;| \\ C_6H_5\cdot C\cdot COOH \\ \quad\;\;| \\ C_6H_5\cdot CO \end{array}$$

Phenyldibenzoylacetic acid.

and



$$\begin{array}{l} C_6H_5\cdot CO \\ \quad\;\;| \\ C_6H_5\cdot CH \\ \quad\;\;| \\ C_6H_5\cdot CO \end{array}$$

Phenyldibenzoylmethane.

Fuming hydriodic acid at its boiling point converts the condensation product into a compound $C_{31}H_{24}O$, which crystallises from a mixture of ethylic acetate and light petroleum in short prisms melting at 187—188°: $C_{34}H_{28}O_6 + 3H_2 = C_{31}H_{24}O + C_2H_6O + CO_2 + 2H_2O$.

Suspecting that the condensation product was a carbethoxyl derivative of anhydracetonedibenzil (Japp and Miller, Trans., 1885, **47**, 34), the authors reduced the latter compound with boiling hydriodic acid, and obtained the foregoing reduction compound $C_{31}H_{24}O$ (m. p. 187—188°) together with an isomeride crystallising from a mixture of ethylic acetate and light petroleum in pyramids melting at 155—159°.

The results do not permit of a conclusion being drawn as to the constitution of the condensation product. The constitution of anhydracetonedibenzil is also unknown.

95. "On a method for preparing the formyl derivatives of the aromatic amines." By H. R. Hirst, and J. B. Cohen, Ph.D.

Formamide reacts with the aromatic primary amines in presence of cold glacial acetic acid, forming formyl derivatives. The mixture is allowed to stand for a few hours, and the product poured into water. The resulting derivative is nearly pure, and the yield is very satisfactory. The reaction takes place according to the equation $R'NH + HCONH_2 + CH_3{\cdot}CO_2H = R'NH{\cdot}COH + CH_3{\cdot}CO_2NH_4$.

The secondary aromatic amines containing an alkyl radicle only react on heating, whereas the tertiary amines and diphenylamine do not react even after continued boiling.

The formyl derivatives of the following bases have been prepared: aniline, ortho- and para-toluidine, α- and β-naphthylamine, phenyl- and orthotolyl-hydrazine, methyl- and ethyl-aniline, paraphenylenediamine, and benzidine.

96. "A modification of Zincke's reaction." By H. R. Hirst, and J. B. Cohen, Ph.D.

A small piece of aluminium foil coated with mercury, which is prepared by dipping the foil into a solution of mercuric chloride, is capable of bringing about a reaction between benzyl chloride, chloroform, &c., on the one hand, and aromatic hydrocarbons on the other. This reaction closely resembles that of Zincke, but takes place at the ordinary temperature. With benzyl chloride and benzene a satisfactory yield of pure diphenylmethane may be obtained. In a similar manner phenyltolylmethane and phenylxylylmethane have been prepared.

97. "A method for preparing cyanuric acid." By W. H. Archdeacon, B.Sc., and J. B. Cohen, Ph.D.

When urea in fine powder is heated in a sealed tube with the calculated quantity of phosgene in 20 per cent. toluene solution, little action occurs until the temperature rises above 180°. A tube which had been heated for four hours at 170—180° showed very little pressure on opening; but, after being resealed and heated for seven hours at 190° and $8\frac{1}{2}$ hours at 230°, great pressure was observed on opening the tube and hydrochloric acid fumes were copiously evolved. The brownish microcrystalline product was separated by filtration and dried *in vacuo*. It amounted in two experiments to 133 and 127 per cent. of the urea used. It dissolved without change in cold concentrated sulphuric acid, being reprecipitated in a crystalline form by water. It dissolved also in alkalis, and from the neutral solution in ammonia silver nitrate threw down a white, amorphous precipitate.

The characteristic needles of the sodium salt, and the amethyst-coloured precipitate with copper ammonium sulphate solution, served to identify the compound as cyanuric acid.

The crude product gave the following result on analysis:—

I. 0·095 gram gave 28·2 c.c. nitrogen at 17° and 737 mm.
II. 0·1753 ,, 0·040 gram H_2O and 0·179 gram of CO_2.

	Theory for $(CONH)_3$.	Found.
C	27·91	27·85
H	2·33	2·53
N.................	32·56	33·38

The reaction probably occurs according to the equation $3CO(NH_2)_2 + 3COCl_2 = 2(CONH)_3 + 6HCl$.

98. "The oximes of benzaldehyde and their derivatives." By C. M. Luxmoore, B.Sc.

The paper contains an account of experiments undertaken with a view to throwing further light on the isomerism of the aromatic aldoximes. As already mentioned in a preliminary note by Professor Dunstan and the author (Proc., 1893, 253), in examining the mechanism of the change of benzantialdoxime into benzsynaldoxime by hydrogen chloride, the previously unknown benzantialdoxime hydrochloride has been isolated; on solution it is converted into the syn-hydrochloride. The two isomeric sulphates have also been prepared. Since the change of the antioxime into its isomeride is always preceded by the formation of a derivative of the former, which then passes into the more stable syn-derivative, a stereo-chemical explanation of the isomerism is rendered probable.

By the action of methyl bromide on benzantialdoxime the hydrobromide of its "nitrogen" methyl ether is produced (m. p. 67°). This ether yields the same products of hydrolysis and reduction as the "nitrogen" methyl ether obtained from bensynaldoxime. It differs from the latter in its lower melting point and in the extreme readiness with which it is hydrolysed. The hydrobromide is stable, but the ether itself rapidly passes on standing into the isomeric syn-nitrogen-ether. Structural formulæ are insufficient to explain the existence of the four isomeric ethers (two "oxygen" and two "nitrogen,") which are known. Probably, therefore, the aldoximes themselves are stereoisomeric; but both act tautomerically, and the synaldoxime reacts more readily in the sense of the isoximido formula than the antialdoxime does.

Treated with phosphorus pentachloride both oximes yield a little formanilide, but chiefly benzonitrile. Phosphorus trichloride converts benzantialdoxime into an extremely unstable chlorine derivative; with benzsynaldoxime it yields benzonitrile and hydrogen chloride instantaneously.

Almost all the stereochemical hypotheses equally well explain the isomerism of oximido-compounds of triad nitrogen; but in the case of derivatives with pentad nitrogen Pickering's theory is more in accordance with facts than any other.

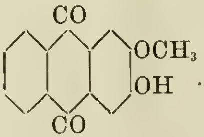
99. "On a colouring matter from 'Lomatia ilicifolia' and 'Lomatia longifolia.'" By Edward H. Rennie, M.A. (Sydney), D.Sc. (Lond.).

The author describes a yellow colouring matter adhering to the seeds of two different species of *Lomatia*, a plant belonging to the order Proteaceæ. The colouring matter is easily extracted by hot water, and is regarded by the author as *hydroxylapachol.* Its barium derivative closely resembles the barium derivative of hydroxyhydrolapachol described by Hooker. When treated with sulphuric acid under certain conditions, it is converted into *hydroxy-β-lapachone.* Other derivatives are described in the paper, and also an isomeric *hydroxylapachol.*

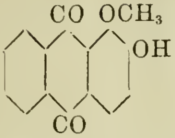
100. "The colouring and other constituents contained in Chay Root. Part II." By A. G. Perkin and J. J. Hummel.

A previous examination of chay root (Trans., 1893, 1160) showed that it contained rubichloric acid, two waxes, cane-sugar, ruberythric acid, alizarine, two dimethyl ethers of anthragallol (A) and (B), m. p. 209°, and 225—227°; an alizarine monomethyl ether, and *m*-hydroxyanthraquinone. By the investigation of very large quantities of the root, 2 cwts., obtained through the Imperial Institute, two new substances have been isolated.

One substance, $C_{15}H_{10}O_4$, was obtained as orange-coloured needles melting at 232°. When heated with hydrochloric acid to 180° it yielded hystazarin, and was found to contain one methoxyl group. It is therefore an *hystazarinmonomethyl ether*,



A second constituent, $C_{16}H_{12}O_5$, formed minute orange-red needles melting at 212—213°, and its acetyl compound at 160°. It contained two methoxy groups, and by the action of hydrochloric acid at 180°, was converted into anthragallol. It was consequently an anthragallol dimethyl ether, and it is interesting to note that chay root therefore contains the three dimethyl ethers of anthragallol.

Since the publication of the previous communication (*loc. cit.*), Schunck and Marchlewski (Trans., 1894, 182) have prepared the alizarine *β*-monomethyl ether from alizarine. This is not identical with that found in chay root, which must consequently be the α-compound, . The readiness with which this is decomposed into alizarine by boiling with dilute alkalis, readily accounts for its non-production by the usual methods.

101. "The six dichlorotoluenes and their sulphonic acids." By W. P. Wynne, and A. Greeves, Assoc. R.C.S.

Sulphonic derivatives of the 1 : 2 : 5- and 1 : 3 : 4-dichlorotoluenes were described in a previous paper (Trans., 1892, 1050, *et seq.*); the present communication deals with the remaining isomerides and their sulphonic acids.

1 : 2 : 3-*Dichlorotoluene* was prepared by three methods: (*a*) from 1 : 2 : 5-nitrorthotoluidine by chlorination, (*b*) from Lellmann and Würthner's 1 : 2 : 3-nitracetorthotoluidide (m. p. 158°, *cf. Annalen*, **228**, 239), and (*c*) from orthochlorotoluenesulphonic acid by nitration. It boils at 207—208° under 760 mm. pressure, and on oxidation yields a dichlorobenzoic acid melting at 164° (*cf.* Seelig, *Annalen*, **237**, 162). On sulphonation two isomeric acids are obtained, which can be separated by means of their barium salts. The acid from the less soluble barium salt forms a very soluble *chloride*, crystallising in radiate needles, melting at 45°, and an *amide*, melting at 221°, whilst that from the more soluble barium salt is the 1 : 2 : 3 : 5-derivative, and like this yields a *chloride*, crystallising in well-defined prisms, melting at 85°, and an *amide*, melting at 183°.

1 : 2 : 4-*Dichlorotoluene* was prepared (*a*) from metatolylenediamine by Erdmann's method (*Ber.*, **24**, 2769), (*b*) from 1 : 2 : 4-nitrorthotoluidine, and (*c*) from orthochlorotoluenesulphonic acid by nitration. It boils at 199—200° under 760 mm. pressure. On sulphonation, it yields the 1 : 2 : 4 : 5-acid, characterised by the *chloride* crystallising in elongated scales, melting at 71°, and the *amide*, melting at 177°.

1 : 2 : 6-*Dichlorotoluene* was prepared from the 1 : 2 : 6-nitrorthotoluidine of Green and Lawson (Trans., 1891, 1013). It boils at 199—200° under 760 mm. pressure, and on oxidation yields a dichlorobenzoic acid melting at 139° (*cf.* Claus and Stavenhagen, *Annalen*, **269**, 228). On sulphonation, an acid is obtained which gives a *chloride*, crystallising in prismatic needles, melting at 60°, and an *amide*, melting at 204°.

1 : 3 : 5-*Dichlorotoluene* was prepared from the 1 : 3 : 4 : 5-dichloroparatoluidine by Lellmann and Klotz's method (*Annalen*, **231**, 321), and from the 1 : 2 : 3 : 5-dichlororthotoluidine of Claus and Stapel

berg (*Annalen*, **274**, 292). It boils at 201—202° under 760 mm. pressure. On sulphonation, an acid is obtained which forms a very soluble *chloride*, melting at 45°, and an *amide*, melting at 168°.

To aid in the determination of the constitution of the dichlorotoluenesulphonic acids, the nitro-derivatives of the five known chlorotoluenesulphonic acids have been prepared and examined. For example, 1 : 2 : 4-orthochlorotoluenesulphonic acid on nitration gives as chief product the 1 : 2 : 4 : 5-nitro-acid, since the dichlorotoluenesulphonic acid obtained from it is identical with that obtained from 1 : 2 : 5-dichlorotoluene (Trans., 1892, 1052). In like manner, 1 : 2 : 5-orthochlorotoluenesulphonic acid is shown to give as chief product the 1 : 2 : 4 : 5-nitro-acid, and as subsidiary product the 1 : 2 : 3 : 5-nitro-acid.

1 : 2 : 3-Nitrorthotoluidine is converted by Sandmeyer's method into the *nitrorthochlorotoluene*, which boils at 263° under 760 mm. pressure. On reduction, this yields the 1 : 2 : 3-*orthochlorometatoluidine*, which boils at 228—229° under 760 mm. pressure, and forms an *acetyl* derivative melting at 132°.

1 : 2 : 4-Nitrorthotoluidine in like manner yields the *nitrorthochlorotoluene*, which crystallises in pale yellow needles, melting at 65°, and the *orthochloroparatoluidine*, which boils at 245° under 760 mm. pressure, and forms an *acetyl* derivative melting at 86°.

1 : 2 : 5-Nitrorthotoluidine on chlorination in the presence of iodine yields a *chloronitrorthotoluidine* melting at 168°. This is the 1 : 2 : 3 : 5-derivative, since, by eliminating the NH_2-radicle, it forms the 1 : 3 : 5-nitrochlorotoluene melting at 61°, the 1 : 3 : 5-chlorometatoluidine, characterised by its acetyl derivative melting at 151° (*cf.* Honig, *Ber.*, **20**, 2419), and 1 : 3 : 5-dichlorobenzoic acid melting at 182°. By Sandmeyer's method the corresponding *nitrodichlorotoluene*, which crystallises in pale yellow needles melting at 83°, was obtained, and from this, by reduction, the *dichlorometatoluidine*, which crystallises in needles, melts at 88°, boils at 292° under 760 mm. pressure, and forms an *acetyl* derivative melting at 187°.

1 : 2 : 6-Nitrorthotoluidine yields a *chlororthotoluidine*, which boils at 245° under 760 mm. pressure, and forms an *acetyl* derivative melting at 154°.

The mixture of dichlorotoluenes obtained by chlorinating orthochlorotoluene under Seelig's conditions (*loc. cit.*), is being examined with the object of determining its constituents.

102. "The disulphonic acids of toluene and of ortho- and parachlorotoluene." By W. P. Wynne, and J. Bruce, Assoc. R.C.S.

As is known (*cf.* Trans., 1892, 1082), parachlorotoluene, on sulphonation, forms a product containing both the 1 : 2 : 4- and 1 : 3 : 4-

sulphonic acids. Experiments have been undertaken with the object of estimating the relative proportions of these acids, both directly and by an examination of the disulphonic acids obtained by sulphonating parachlorotoluene with 20 per cent. anhydrosulphuric acid. For the purposes of comparison, chloro-acids have been prepared by Sandmeyer's method from the paratoluidinemono- and -disulphonic acids of known constitution.

The paratoluidinedisulphonic acids obtained by Richter from the 1 : 3 : 4- and the 1 : 2 : 4-paratoluidinemonosulphonic acids (*Annalen*, **230**, 314, 331), are shown to be the 1 : 3 : 4 : 6- and 1 : 2 : 4 : 6-derivatives respectively. The former, by elimination of the NH_2-radicle, gives a toluenedisulphonic acid identical with that obtained from the 1 : 2 : 5-orthotoluidinesulphonic acid by the xanthate method.

1 : 2 : 4-Parachlorotoluenesulphonic acid, prepared from the corresponding amido-acid, gives a sparingly soluble *barium* salt, a *chloride* melting at 23—24°, and an *amide* melting at 142°. On sulphonation with 20 per cent. anhydrosulphuric acid, it yields, as sole product, an acid identical with that obtained from the 1 : 2 : 4 : 6-paratoluidinedisulphonic acid.

1 : 3 : 4-Parachlorotoluenesulphonic acid, obtained from the corresponding amido-acid, gives an easily soluble *barium* salt, a *chloride* crystallising in plates melting at 54°, and an *amide* melting at 154°. On sulphonation with 20 per cent. anhydrosulphuric acid, two disulphonic acids are obtained, the chief product being the 1 : 3 : 4 : 6-derivative, since it is identical with the acid obtained from the 1 : 3 : 4 : 6-paratoluidinedisulphonic acid.

Parachlorotoluene, on sulphonation with 20 per cent. anhydrosulphuric acid under similar conditions, gives a mixture of the 1 : 2 : 4 : 6- and 1 : 3 : 4 : 6-disulphonic acids in the proportions of about three parts of the former to one of the latter.

The 1 : 2 : 3 : 5-orthotoluidinedisulphonic acid prepared by Hasse's method (*Annalen*, **230**, 286), and shown to be identical with Hasse's product by conversion into the bromotoluenedisulphonic chloride, gives, by the hydrazine method of eliminating the NH_2 radicle, a toluenedisulphonic acid, which differs from that described by Hasse since its chloride (Cl found 24·5, Hasse 25·9, theory 24·6) melts, not at 132°, but at 95°.

1 : 2 : 5-Orthochlorotoluenesulphonic acid gives, on further sulphonation, a product which seems to differ from that obtainable from Hasse's acid by Sandmeyer's method, and is being further examined.

In addition to the known 1 : 2 : 4-, 1 : 2 : 5-, and 1 : 3 : 5-toluenedisulphonic acids, the following have been prepared :—

1 : 2 : 6-*Toluenedisulphonic acid*, obtained from the 1 : 2 : 4 : 6-paratoluidinedisulphonic acid by eliminating the NH_2-radicle, forms a *potassium* salt crystallising with $1\frac{1}{2}H_2O$ in minute prisms, and a *chloride*, crystallising in scales, melting at 99°.

1 : 3 : 4-*Toluenedisulphonic acid*, obtained from the 1 : 3 : 4-paratoluidinemetasulphonic acid by the xanthate method, forms a monohydrated *potassium* salt crystallising in needles, and, on treatment with phosphorus pentachloride yields the *chloride*, which crystallises from benzene with $\frac{1}{2}$ mol. proportion of benzene in large prisms melting at about 60°, and from petroleum spirit in scales melting at 111°.

103. "Contributions to our knowledge of the aconite alkaloïds. Part XII. The constitution of pseudaconitine. Preliminary notice." By Wyndham R. Dunstan, F.R.S., and Francis H. Carr.

Pseudaconitine is the name given by Alder Wright to the highly toxic alkaloïd contained in Nepaul aconite (*Aconitum ferox*). It is a crystalline base, melting at 104—105°, whose composition is expressed by the formula $C_{36}H_{49}NO_{12}$. When hydrolysed, it furnishes, according to Alder Wright and Luff (Trans., 1878), *pseudaconine* and 1 molecular proportion of *dimethylprotocatechuic acid* (veratric acid), $C_{36}H_{49}NO_{12} + H_2O = C_{27}H_{41}NO_9 + C_9H_{10}O_4$. The authors are engaged in a re-investigation of this alkaloïd in the light of their recent work on the constitution of aconitine derived from *Aconitum napellus*, (Trans., 1894, 176, 290).

The pseudaconitine employed by the authors was extracted from the roots of *Aconitum ferox*, some of which were provided by the Government of India through the Imperial Institute. The highly-purified crystalline base melted at 201°, that is, nearly 100° higher than the point recorded by Wright and Luff; this melting point was not changed by fractional crystallisation.

When heated slightly above its melting point, pseudaconitine loses a molecular proportion of acetic acid, leaving a new base which it is proposed to name *pyropseudaconitine*. This alkaloïd, on hydrolysis, loses a molecular proportion of dimethylprotocatechuic acid, furnishing *pyropseudaconine*.

On complete hydrolysis with alkali, pseudaconitine yields, in addition to the dimethylprotocatechuic acid observed by Wright and Luff, a molecular proportion of acetic acid, which was identified and estimated in the manner described in the authors' previous paper on aconitine.

When pseudaconitine sulphate is heated in a closed tube with water it suffers, like aconitine, partial hydrolysis, the acetyl group alone being eliminated, producing a molecular proportion of acetic acid. In this action a new alkaloïd is formed, corresponding with the benzaconine derived in a similar manner from aconitine, which the authors propose to name *veratrylpseudaconine.* This substance is a crystalline base (m. p. 181°) which, when hydrolysed, furnishes pseudaconine and dimethylprotocatechuic acid (veratric acid).

There is therefore a close resemblance between the constitution of aconitine and of pseudaconitine, both alkaloïds undergoing hydrolysis in a similar manner. The molecule of each alkaloïd contains an acetyl group, but in pseudaconitine the benzoyl group of aconitine is replaced by the veratryl group, aconitine being *acetylbenzaconine*, and pseudaconitine, *acetylveratrylpseudaconine.* As far as the authors' investigation has proceeded, pseudaconine appears to be distinctly different from the aconine derived from aconitine. There is little reason at present to doubt that the crystalline highly active alkaloïd isolated by the authors is identical with Wright's pseudaconitine, but further evidence on this point is being obtained.

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From the Publishers.

Chemistry, Inorganic and Organic, with Experiments by Charles Loudon Bloxam. Eighth edition. Rewritten and revised. By John Millar Thomson and Arthur G. Bloxam. Pp. xii + 848. 8vo. London 1895.
From the Editor.

Transactions of the New York Academy of Medicine. 2nd series. Vol. X, for 1893. 8vo. Pp. xii + 686. New York 1894.
From the Academy.

Chemistry of Urine: A practical guide to the Analytical Examination of Diabetic, Albuminous, and Gouty Urine. By Alfred H. Allen, F.I.C., F.C.S., &c. 8vo. Pp. xii + 212. London 1895.
From the Author.

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Relation remarquable entre les poids Atomiques des Éléments Chimiques. Poids atomiques rationnels. Par Julius Thomsen. 1894. From the Author.

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Notes on the Retention of Urea Elimination to Fever. By Professors H. C. Wood and Jno. Marshall. 1891. From the Authors.

The Art of Casting Bronze in Japan. By W. Gowland, A.R.S.M., F.C.S., F.S.A. A paper read before the Applied Art Section of the Society of Arts, April 23rd, 1895. Reprinted from the *Journal of the Society of Arts*, May 3, 1895. From the Author.

Engineering Heliography, or the Sun Print copying of Engineering Drawings. A paper read before the North of England Institute of Mining and Mechanical Engineers. By B. H. Thwaite, C. E. General Meeting at Newcastle-upon-Tyne, February 9th, 1895. From the Author.

Ueber die sag. "Künstlichen" Mineralwässer von C. Glucksmann. Separat—Abdruck aus der Zeitschrift für die gesammte Kohlensäure Industrie. Berlin 1895.

Om Iridiums Ammoniakaliska Föreningar. Akademisk Afhandling af K. Vilh. Palmær. Upsala 1895.

Om Sulfonering af β-naftylamin. Akademisk Afhandling af Sven Forsling. Uppsala 1895.

Om de fem- och sexledade aromatiska thiohydantoinernas Konstitution. Af N. A. Langlet.

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On some Conditions affecting the Accuracy of the Determination of Potash as Potassium Platinichloride. By A. L. Winton, Connecticut Agricultural Experiment Station. From the Author.

Boleite, Nantokite, Kerargyrite, and Cuprite from Broken Hill, New South Wales. By A. Liversidge, M.A., F.R.S., Professor of Chemistry in the University of Sydney (with Plate II). From the Author.

Cape of Good Hope. Department of Agriculture. Report of the Senior Analyst on the Analytical Laboratory for the year 1894. From the Department.

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Handbuch der Chemischen Technologie unter Mitwirkung von Direktor Th. Beckert, Dr. Bender, Dr. Benedict, Dr. Börnstein, Dr. Brand, Dr. Buntrock, Dr. Hecht, Dr. von Helmolt, Dr. Jurisch, Dr. Lange, Prof. Dr. Prausnitz. Herausgegeben von Dr. O. Dammer. Fünf Bande. I Band. Mit 191 in den text gedruckten figuren. 8vo. Pp. xvi+920. Stuttgart 1895.

Alembic Club Reprints. No. 10. Researches on the Arseniates, Phosphates, and Modifications of Phosphoric Acid. By Thomas Graham, F.R.S. 1833.

Tabellarische Uebersicht über der künstlichen organischen Farbstoffe und ihre Anwendung in Färberei und Zeugdruck. Von Dr. Adolf Lehne. Mit Ausfärbungen jedes einzelnen Farbstoffes und Zeugdruckmustern. Pp. xxv+102. Specimens of 324 dyes. 4to. Berlin 1893.

Analysis of Milk and Milk Products. By Henry Leffman, M.D., Ph.D., and William Beam, M.A., M.D. 8vo. Pp. 92 Philadelphia, 1893.

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RESEARCH FUND.

The following grants have been made by the Council on the recommendation of the Research Fund Committee:—

£30 to Messrs. J. J. Hummel and A. G. Perkin, for the investigation of certain natural colouring matters.

£10 to Dr. H. Ingle, for the purchase of various aldehydes, ketones, and hydrazine to continue his work on stereoisomeric osazones.

£10 to Dr. J. J. Sudborough, to continue his work on diortho-substituted benzoic acids.

£15 to Mr. E. Haworth, for the synthesis of an acid having the composition $C_8H_{14}(COOH)_2$, and the comparison of its properties with those of camphoric acid.

£5 to Mr. R. E. Doran, for a research on the preparation of mustard oils by the reaction of chlorocarbonic esters with lead thiocyanate.

£15 to Dr. W. A. Bone, to continue a research on the substituted succinic acids, and on the behaviour of various trimethylene compounds on treatment with the sodium compound of ethylic malonate.

£10 to Dr. B. Lean, to extend his work on the derivatives of ethylic butane tetracarboxylate.

£20 to Dr. J. Walker, for an investigation of the conditions of equilibrium between the cyanates and the corresponding ureas.

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Issued 20/11/1895.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

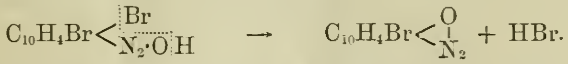
EDITED BY THE SECRETARIES.

No. 155. Session 1895–96.

The following are the abstracts of papers received during the vacation, and published in the Transactions:—

104. "Homonucleal tri-derivatives of naphthalene." By Raphael Meldola F.R.S., and Frederick William Streatfeild.

Dibromonitronaphthalene, $C_{10}H_5Br\cdot NO_2\cdot Br$ (1 : 2 : 4), m. p. 117°, has been prepared by the authors and submitted to further study. The corresponding dibromo-β-naphthylamine consists of white, silky needles melting at 106—107°; the acetyl derivative melts at 220—221°. When this dibromo-β-naphthylamine is diazotised in the presence of an excess of mineral acid and the diazo-salt solution boiled with water, the NH_2-group is not replaced by hydroxyl, as in the normal Griess reaction, but bromine is displaced, and a diazoxide formed in accordance with the scheme



$$C_{10}H_4Br{<}{\scriptstyle\begin{matrix}Br\\ N_2\cdot O\cdot H\end{matrix}} \longrightarrow C_{10}H_4Br{<}{\scriptstyle\begin{matrix}O\\ |\\ N_2\end{matrix}} + HBr.$$

The diazoxide has the constitution $\overline{O : N_2} : Br = 1 : 2 : 4$. It consists of ochreous needles, soluble in boiling water, and decomposing at 148—151°. It is reduced by tin and hydrochloric acid to β-amido-α-naphthol, and bromine and glacial acetic acid converts it into dibromo-α-naphthaquinone, m. p. 216°.

Chlorobromo-β-naphthylamine, $C_{10}H_5Cl\cdot NH_2\cdot Br$ (1 : 2 : 4), was obtained in the form of white, silky needles melting at 102—103°; the acetyl derivative at 218°, the benzoyl derivative at 185—186°. By nitrous acid this chlorobromo-β-naphthylamine is converted into the diazoxide, above described, in the presence of excess of mineral acid; in its absence the diazoamide, $C_{10}H_5ClBr\cdot N_2\cdot NH\cdot C_{10}H_5ClBr$, is formed.

This compound is very stable for a diazoamido-compound, and crystallises from toluene in yellowish needles melting at 205—210°, with decomposition. The authors also show that iodine chloride is an excellent reagent for preparing iodine derivatives of the acetnaphthalides, both α and β. They give the melting points of the following compounds:—$C_{10}H_4I{\cdot}NHAc$ (4 : 1), 197°; $C_{10}H_5{\cdot}NO_2{\cdot}I{\cdot}NHAc$ (2 : 4 : 1); $C_{10}H_5{\cdot}NO_2{\cdot}I{\cdot}OH$ (2 : 4 : 1), 150° (shrinking at 147°); $C_{10}H_5{\cdot}NO_2{\cdot}I{\cdot}OC_2H_5$ (2 : 4), 104—105°. The potassium salt of the nitroiodonaphthol has also been prepared and analysed.

105. "The ethereal salts of the optically active lactic, chloropropionic, and bromopropionic acids." By J. Wallace Walker, M.A.

The methylic, ethylic, and propylic ethereal salts of active lactic acid were prepared by the action of the alkyl iodides on the anhydrous silver salt. From the ethereal lactates the corresponding bromopropionic salts were prepared by the action of phosphorus pentabromide. For both series of salts there is a constant difference in rotatory power, in the first case of 5·5°, in the second of 14·2°, between two adjacent members. The ethereal chloropropionates were prepared by the action of phosphorus pentachloride on lactic acid. These bodies possess a high degree of optical activity, and the values given in this paper are much higher than those found by Le Bel, Walden, and Frankland and Henderson for such of the substances as they have examined. The observed results do not agree with Guye's hypothesis.

106. "Some new azo-compounds." By Charles Mills.

By the action of nitrosobenzene on aniline dissolved in acetic acid azobenzene is produced (Baeyer, *Ber.*, 7, 1638). The author has extended this reaction, and has prepared the following substances:—

m-*Acetylamidoazobenzene*, m. p. 130—131° C. On hydrolysis with caustic soda it gives m-*amidoazobenzene*, crystallising from light petroleum spirit in long, silky, orange needles, m. p. 56—57° C. Readily soluble in alcohol, acetic acid, ethyl acetate, acetone, chloroform, benzene and ether. $C_6H_5{\cdot}N_2{\cdot}C_6{\cdot}H_4{\cdot}N_2{\cdot}C_6H_5$, *diparadiphenyldisazophenylene*, prepared by the action of nitrosobenzene on *p*-amidoazobenzene. p-*Benzeneazotoluene* formed by the action of nitrosobenzene on *p*-toluidine, also by the action of *p*-nitrosotoluene on aniline.

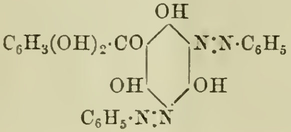
The following compounds are also described:—

p-*Benzeneazotoluenesulphonic chloride*. p-*Benzeneazo*-o-*acettoluide*, $C_6H_3{\cdot}CH_3{\cdot}NHAc{\cdot}N{:}N{\cdot}C_6H_5$ (1 : 2 : 4). m-*Amido*-p-*benzeneazotoluene*. *Benzene*-o-*azo*-o-*acettoluide*, $C_6H_4{\cdot}NHAc,CH_3{\cdot}N{:}N{\cdot}C_6H_5$ (1 : 2 : 3). m-*Amidobenzene*-o-*azotoluene*, $C_6H_4{\cdot}NH_2{\cdot}CH_3{\cdot}N_2{\cdot}C_6H_5$ (1 : 2 : 3).

107. “Some derivatives of Maclurin.” By C. S. Bedford, and A. G. Perkin.

When an aqueous extract of old fustic (*Morus tinctoria*) is treated with a solution of diazobenzene sulphate, a colouring matter is produced. The chief constituents of old fustic are, morin, $C_{15}H_{10}O_7$, and maclurin, $C_{13}H_{10}O_6$, only the latter reacts readily with diazobenzene. Benzeneazomaclurin, $C_{13}H_8O_6(C_6H_5{\cdot}N_2)_2$, *o*- and *p*-tolueneazomaclurin, *p*-nitrobenzeneazomaclurin, and maclurinazobenzene-*p*-sulphonate of sodium have also been prepared. These substances dye wool and silk orange-coloured to deep brown shades. Maclurin, by the action of reducing agents, yields phloroglucin and protocatechuic acid, and is considered to be a pentahydroxybenzophenone, $C_6H_3(OH)_2{\cdot}CO{\cdot}C_6H_2{\cdot}(OH)_3$.

Phloroglucin combines with 2 mol. props. of diazobenzene, while no reaction takes place between this latter and protocatechuic acid. The constitution of benzeneazomaclurin should therefore be thus represented,



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108. “The constituents of ‘Artocarpus integrifolia.’” By A. G. Perkin and F. Cope.

Artocarpus integrifolia is the well known Jack Fruit, cultivated in India, Burmah, and Ceylon. It is much esteemed for carpentry, and is used in conjunction with alum as a yellow dye. It contains a yellow colouring matter of the formula, $C_{15}H_{10}O_7$, identical with *morin*, and a substance of the formula $C_{15}H_{12}O_6$, to which the name *cyanomaclurin* has been given. With diazobenzene it yields a compound, $C_{15}H_{10}O_6(C_6H_5N_2)_2$, crystallising in scarlet needles, which dyes unmordanted wool and silk orange to orange-red shades, but which does not dye with mordants. When boiled with dilute acids, cyanomaclurin yields red-brown products, resembling in character the so-called “anhydrides” of catechin, which can be produced from this latter substance in a similar way. That first formed dissolves in hot water and dilute alkalis, but by longer treatment becomes more sparingly soluble, and the final product obtained is insoluble in dilute alkalis and the usual solvents. No glucose is produced during this reaction, so that cyanomaclurin is not a glucoside. The study of this substance will be continued.

109. "Optically active methoxy- and propoxy-succinic acids." By T. Purdie, F.R.S., and H. W. Bolam, B.Sc.

The authors have resolved inactive methoxy- and propoxy-succinic acids into their active components, the cinchonine and strychnine salts being made use of in the case of methoxysuccinic acid, the strychnine salts in the case of the propoxysuccinic acid.

Rotations of the acids in water and different organic solvents are given, with the rotations of salts of both acids in aqueous solution.

110. "Ethereal salts of active methoxy- and ethoxy-succinic acids." By T. Purdie, F.R.S., and S. Williamson, Ph.D.

Inactive methoxy- and ethoxy-succinic acids were resolved into their active components by means of their strychnine salts. Observations on the activity of the various strychnine salts in aqueous solution were made, and results obtained in accordance with the law of Oudemans.

Methyl-, ethyl-, propyl-, and butyl-, methoxy- and ethoxy-succinates, and the isopropyl and isobutyl salts of ethoxysuccinic acid, were prepared by the action of their respective iodides upon the silver salts of the acids, and their rotations observed.

The specific rotations of the active acids in water and various organic solvents were also taken. A discussion of the results obtained is contained in the paper.

111. "Note on the production of potassium platinichloride." By E. Sonstadt.

Dry potassium platinichloride, when heated with mercury, is decomposed according to the proportion of mercury used.

$$\text{(1.)}\ 2KCl,PtCl_4 + 4Hg = 2KCl + Pt + 4HgCl.$$

$$\text{(2.)}\ 2KCl,PtCl_4 + 2Hg = 2KCl + Pt + 2HgCl_2.$$

The decomposition begins even below 100° C., and is complete at a lower temperature than is required to expel from the containing vessel the mercurous or mercuric chloride produced.

In treating small quantities of the platinichloride, the mercury is placed in a porcelain crucible, and covered with platinichloride, in the proportion of about two parts of mercury to one of salt. Heat is applied very gently, to avoid loss through boiling, till the reaction is complete, when the heat is raised to expel the mercurous chloride.

When larger quantities are decomposed, the salt is preferably triturated with the mercury, and gently heated, so as to avoid a too sudden or violent reaction.

ADDITIONAL NOTE BY AUTHOR.—Dry silver chloride is not decomposed by mercury, even at a red heat; nor when mixed or combined with a platinum salt.

112. "Orthobenzoic sulphinide." By William J. Pope.

The author finds that pure orthobenzoic sulphinide in large well-defined crystals may be obtained from the commercial mixture known as "saccharin" by crystallisation from acetone. Crystallographical measurements are given.

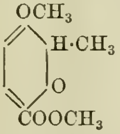
113. "Derivatives of β-resorcylic acid." By A. G. Perkin.

The principal product of the action of methylic iodide upon β-resorcylic acid is a substance crystallising in needles melting at 76—77°, and having the constitution $C_6H_2{\cdot}Me(OMe){\cdot}OH{\cdot}COOMe$. It appears probable that the hydroxyl group in β-resorcylic acid, which resists methylation, is in the *o*-position to the carboxyl group.

The principal product of the action of ethylic iodide upon β-resorcylic acid is insoluble in alkalis, and contains but two ethoxy-groups. It has the formula $C_6H_3(OEt)(OH){\cdot}COOEt$.

The action of methylic iodide upon resacetophenone has been studied, but the results have been anticipated by Gregor (*Monatsh*, 1894, **15**, 437). The principal product is a substance having the constitution $C_6H_2(OMe){\cdot}(OH){\cdot}Me{\cdot}COCH_3$, insoluble in alkalis, and resembling the results of the action of methylic iodide upon β-resorcylic acid.

It appears probable that the insolubility of the methyl and ethyl ethers of β-resorcylic acid and resacetophenone, which apparently contain a free hydroxyl group, is due to the fact that the oxygen of this latter has assumed the ketonic form. The constitution of the two former substances would therefore be



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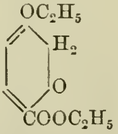

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Preliminary experiments on the methylation of gallacetophenone have yielded a substance melting at 76—77°, apparently a dimethylether, $C_6H_2(OMe)_2{\cdot}OH{\cdot}CO{\cdot}CH_3$.

Gallacetophenone oxime, $C_6H_2(OH)_3{\cdot}C{:}NOH{\cdot}CH_3$, and *quinacetophenone oxime*, $C_6H_3(OH)_2{\cdot}C{:}NOH{\cdot}CH_3$, were also obtained.

114. "Note on the gravimetric estimation of maltose by Fehling's solution." By T. A. Glendinning.

The specific cupric-reducing power of maltose possesses a different value according to whether potash or soda is the alkali employed in the preparation of Fehling's solution. Under the conditions of experiment given, the reducing powers to be attributed to maltose, are :—Soda, $K_{3\cdot86} = 61$. Potash, $K_{3\cdot86} = 64$.

On making comparative analyses of starch-transformation products with the two kinds of Fehling's solution, identical results were obtained, provided the respective values of K were used.

No such difference occurs in the case of dextrose or of invert sugar.

115. "Studies in the malonic acid series." By S. Ruhemann, Ph.D., M.A., and K. J. P. Orton, B.A.

The authors have investigated the action of ammonia, hydrazine, and phenylhydrazine on dibromomalonamide. Ammonia yields diaminomalonamide, $C(NH_2)_2(CONH_2)_2$; and hydrazine and phenylhydrazine give the hydrazone and phenylhydrazone respectively of malonamide.

Fuming nitric acid acts on malonamide forming nitromalonamide. Aniline, when heated with nitromalonamide until ammonia ceases to come off, yields diphenylurea.

On reduction of nitromalonamide with sodium amalgam, aminomalonic acid is obtained.

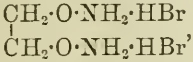
By permission of Professor Claisen, the authors have investigated the action of hydrazine hydrate on ethyl ethoxymethylenemalonate. They obtain a result which does not agree with that of V. Rothenberg.

116. "Mercury perchlorates." By M. Chikashigé.

Mercuric perchlorate is not anhydrous, its composition being $Hg(ClO_4)_2,6H_2O$. It slowly loses, in a desiccator, acid and water, and effloresces. In the air it is very deliquescent (Serullas). When heated, it melts completely at 34° (in dry air); as the temperature rises to 150°, it very slowly decomposes, giving off water and perchloric acid, while a white, basic perchlorate, $Hg_3O_2(ClO_4)_2$, is left, permanent at that temperature. If the salt is heated in a long narrow tube, it may be kept in a bath at 400°, for any time, without permanent decomposition, boiling freely and retaining its transparency, and, when cooled, solidifying unchanged. Whilst heated it is, however, continuously decomposing into basic salt and acid and water, but as the acid and water vapours condense and flow back, the salt is continuously reformed, and presents only the phenomena of ebullition.

Mercurous perchlorate has the composition $(HgClO_4)_2,4H_2O$, according to the author; Roscoe found $6H_2O$. In a vacuum desiccator it loses in two weeks $2H_2O$ and a very little acid, and then ceases to lose weight. It is slowly decomposed by heat, even at 100° or less, in dry air, first losing water and perchloric acid, then gradually, from 150° upwards, becoming mercuric salt, and yielding chlorides and a little chlorate. It resembles mercuric perchlorate in its decomposition, but does not show the phenomena of fusion and ebullition. According to Roscoe, mercurous perchlorate does not lose weight in a vacuum over sulphuric acid, or at 100°.

117. "*a*-Ethylene dihydroxylamine dihydrobromide." By C. M. Luxmoore, D.Sc.

When ethylene bromide is heated with a solution of hydroxylamine in methyl alcohol to 100°, two mols. of the latter combine with one of the former to form the dihydrobromide of ethylene dihydroxylamine, a white, crystalline substance, soluble in water and alcohol, insoluble in ether. When reduced with hydriodic acid, all the nitrogen is obtained as ammonia. The constitution of the substance is therefore  $\begin{array}{l} CH_2{\cdot}O{\cdot}NH_2{\cdot}HBr \\ \vert \\ CH_2{\cdot}O{\cdot}NH_2{\cdot}HBr \end{array}$, and its formation lends some support to the view that free hydroxylamine has the structure $O{\equiv}NH_3$.

Ethylene oxide also reacts with hydroxylamine, forming apparently the base corresponding with the hydrobromide described above.

118. "The alleged isomerism of potassium nitrososulphate." By C. M. Luxmoore, D.Sc.

Potassium nitrososulphate, whether prepared by the absorption of nitric oxide, by potassium sulphite, or by the absorption of a mixture of sulphur dioxide and nitric oxide by potassium hydroxide, has always the same properties. Hantzsch's silver salt, ($KAgSN_2O_5$), has been obtained from specimens prepared in these different ways, and showed the characteristic behaviour described by him.

Potassium nitrososulphate reaches a temperature of about 134° (as indicated by a thermometer embedded in the salt) before it explodes, the gradual and quiescent decomposition into potassium sulphate and nitrous oxide that precedes the explosion furnishing the heat that raises the temperature of the substance above that of the bath in which it is heated.

Pelouze's account of the properties of this substance can be completely reconciled with the recent observations of Hantzsch and of Divers and Haga, with the exception of the statement that it loses no weight when heated to 110°, which is evidently a mistake. Five minutes' heating below 105° causes a loss of weight of $2\frac{1}{2}$ per cent.

There is no evidence to warrant the suggestion of Hantzsch that Raschig's first salt is isomeric with potassium nitrososulphate, nor can it be regarded as identical with the salt prepared by Davy and Pelouze.

119. "On the freezing points of silver and gold." By C. T. Heycock, F.R.S., and F. H. Neville.

The authors draw attention to the close agreement between the determination of the freezing point of gold, by Callendar, in 1892, and their own determinations in 1894. The platinum temperatures differ by a few degrees, but, when reduced to the scale of the air thermometer by the same method, the two results do not differ by more than one degree. The authors further consider the influence of various gases on the freezing point of silver. They find that the highest and steadiest freezing points are obtained in the presence of free hydrogen or of coal gas, and that nitrogen or carbon dioxide produce little or no depression. They find that the well-known effect of oxygen on the freezing point of silver may amount in extreme cases to a depression of 20° C., but that the oxygen can be removed by the action of nitrogen or hydrogen.

November 7th, 1895. Mr. A. G. Vernon Harcourt, President, in the Chair.

Messrs. A. F. Fuerst, T. F. H. Gilbard, E. T. Read, and A. Stansfield were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of the Earl of Berkeley, Boars Hill, Abingdon; Messrs. Arthur Jenner Chapman, Burleigh House, Yerbury Road, Upper Holloway; George Bertram Cockburn, B.A., St. George's Hospital, S.W.; Charles Crocker, St. Peter's Road, Cockett, Swansea; Gurney Cuthbertson, 69, Shoreham Street, Sheffield; William Dixon, 102, Spring Street, Bury, Lancs.; Patrick Joseph D. Fielding, 8, St. Joseph's Place, Cork; James Gardner, 80, Heaton Terrace, Middleton, near Manchester; Edward Graham, B.Sc., Dalton Hall, Manchester; Edgar Septimus Hanes, 108, Alexandra Road, St. John's Wood, N.W.; Thomas Hawkins Percy Heriot, 23, Wolseley Road, Crouch End, N.; Frederick Arthur Hillard, B.A., 1, Upper Tichborne Street, Leicester; Arthur Edward Holme, M.A., 3, Ash Terrace, Savile Town, Dewsbury; Alfred James, 18, St. Andrews Drive, Pollokshields, N.B.; Frederick Edward Johnson, 16, Stanley Terrace, West Park, Hull; Leonard P. Kinnicutt, Ph.D., &c., Worcester, Mass., U.S.A.; Walter Mansfield, Trafalgar House, Broughton, Lancs.; Cecil Massey, Lyndon House, Lenton Boulevard, Nottingham; James McCreath, 4, Lombard Court, E.C.; David James Morgan, 10, Northampton Place, Swansea; Herbert Peck, Wigan Road, Ormskirk; William Round, 45, St. Peter's Road, Handsworth, Birmingham; Clarence Arthur Seyler, B.Sc., 31, Windsor Terrace, Swansea; Matthew Smith, B.A., Aston Hall, Preston Brook, Cheshire; Frank Robert Stephens, Idris & Co., Camden Town, N.W.; George Stone, Sydney, N.S.W; Albert Thorpe, Charnwood House, Sleaford Road, Preston; John Williams, B.A., Wesley College, Sheffield; Thomas Rowland Wingfield, 43, Dorset Street, Bolton; William Chattaway, Apothecaries Hall, Blackfriars, E.C.; Martin Priest, Apothecaries Hall, Blackfriars, E.C.; William Oakes Kibble, Norton Villa, Buckhurst Hill, Essex.

The PRESIDENT announced that the following telegram had been sent to Madame Pasteur on the death of her husband, M. Louis Pasteur, in October last—

"Madame Pasteur, Institut Pasteur, Rue Dutot, Paris.

"The Chemical Society of London, in common with the entire scientific world, mourns the loss of its illustrious Foreign Member and begs to express to you its deepest sympathy,

"VERNON HARCOURT, *President.*
"T. E. THORPE, *Treasurer.*
"JOHN M. THOMSON,
"WYNDHAM R. DUNSTAN, } *Secretaries,*"
"R. MELDOLA,

and that the following Address had been presented on behalf of the Society by Dr. Frankland to the Institute of France on the occasion of its Hundredth Anniversary:—

"The leading men of the French nation in Literature, Science, and Art celebrate to-day the hundredth anniversary of a great event. There had perished in the throes of the revolution a group of Academies which for more than a hundred years had shed lustre upon France, and had contributed among the foremost to the general advance of mankind. It was an eclipse of which the darkness could not last long. Two years later, on the 25th of October, 1795, the law was passed which revived the Academies and combined them in the Institute.

"The Chemical Society of London, born half a century later and representing one of the sciences which are united under the Académie des Sciences Mathématiques et Physiques desire on this occasion to record their sense of the splendid additions to chemical knowledge and thought which have been made by members of the

French Academy. They respectfully offer to the Institute their congratulations on what has been achieved, to which they must now add their sympathy and regret for those who have passed away, thinking especially of the recent loss which science and humanity have sustained by the death of the illustrious Pasteur.

Seal.	"*President.*	A. VERNON HARCOURT.
	"*Treasurer.*	T. E. THORPE.
	"*Honorary Secretaries.*	JOHN M. THOMSON. WYNDHAM R. DUNSTAN.
	"*Foreign Secretary.*	RAPHAEL MELDOLA."

October 25th, 1895.

Of the following papers those marked * were read:—

*120. "On flame temperatures and the acetylene theory of luminosity."

By Arthur Smithells, B.Sc.

The author has submitted to experimental and critical examination the acetylene theory of luminous hydrocarbon flames advocated by Lewes (Trans., 1895, **61**, 322; *Proc. Roy. Soc.*, 1895, **57**, 450), and concludes that it is untenable.

Details of the measurement of the temperatures of different parts of hydrocarbon flames by means of the Le Chatelier thermo-couple are given. It is shown that to obtain readings of any value the wires constituting the couple must be bent so as to fit the particular region of the flame in which the measurement is desired, and that if the sheet of flame be thin, even this precaution is insufficient. The exploration of an ordinary flat coal-gas flame gives evidence of no sudden change of temperature in a vertical plane. Sudden changes are found, however, when the couple is moved from the middle of the flame outwards in a horizontal plane, and the mantle has a temperature higher than the melting point of platinum.

The author considers Lewes's description of the distribution of zones in flames to be based on erroneous temperature measurements, and finds no evidence of such a local condition of temperature as would point to the decomposition of acetylene. The conclusion in favour of the acetylene theory, based on the comparative luminosity of the ethylene and acetylene flames, is attributed to neglect of the consideration that in the latter there is a higher temperature and a greater relative amount of carbon. The indirect evidence derived from the behaviour of cyanogen is stated to arise from the yellow ammonia flame having been mistaken for one containing solid carbon. The theoretical arguments based on thermo-chemical considerations are adversely criticised.

The author maintains that the luminosity of hydrocarbon flames, including the flame of acetylene, can be adequately explained on the older theory of their structure confirmed and extended by his earlier experiments (Trans., 1892, **61**, 217). According to this view, a luminous flame is invested by a sheath of gas in non-luminous combustion. This sheath, which is double at the lower part, corresponds to the two cones of a Bunsen flame, and produces an exceedingly high temperature. The gas within this sheath is intensely heated as it ascends, and is gradually decomposed so as to furnish a sheet of carbon particles, becoming more and more numerous. These glow partly by heat and partly by combustion; the higher the temperature of the non-luminous sheath, and the greater the relative number cf particles, the brighter will be the flame. This is well seen in the case of acetylene. The author believes that the precise steps in the decomposition of a hydrocarbon by which carbon is deposited are at present unascertainable by any direct means, but as the glow of the carbon particles in a hydrocarbon flame is in no case greater than that acquired by a platinum wire immersed in the same region, he considers that there is no ground fcr supposing that the endothermic decomposition of acetylene (of which substance only a very small quantity has been found in the flame gases) plays any appreciable part in the phenomenon.

*121. "A new series of hydrazines." By Frederick D. Chattaway, B.A., and Harry Ingle, B.Sc.

Primary and secondary hydrazines have proved such important substances that other substituted derivatives of hydrazine have scarcely been studied.

Theoretically, hydrazine should yield five series of substituted derivatives, of which only three are known, the primary, the secondary symmetrical, and the secondary unsymmetrical. No simple method of obtaining members of the other series has hitherto been described, and the authors have undertaken their investigation.

The quaternary hydrazines, which are dealt with in the paper, can be obtained by a simple general reaction from the secondary amines.

The secondary amine is treated with sodium or sodium ethylate, whereby the hydrogen atom is replaced by sodium, $R_2NH + Na = R_2NNa + H$. The equivalent quantity of iodine is then allowed to act upon the sodium compound, when the sodium atoms are withdrawn, and the two substituted amido-groups unite to form the quaternary hydrazine, $R_2N{\cdot}Na + I_2 + Na{\cdot}NR_2 = R_2N{\cdot}NR_2 + 2NaI$.

The aromatic quaternary hydrazines which have been so far more especially studied are stable, well-crystallised compounds, which are not easily oxidised and are scarcely if at all basic. Their percentage composition and the molecular weights obtained by Raoult's method, using benzene as a solvent, agree well with the theoretical.

Tetraphenyl hydrazine, $(C_6H_5)_2N{\cdot}N(C_6H_5)_2$, obtained by the above reaction from diphenylamine, crystallises in long, orthorhombic prisms, m. p. 147°. It is easily soluble in benzene, chloroform, and acetone, and dissolves in cold concentrated sulphuric acid, giving a deep purple solution.

Tetra-p-*tolyl hydrazine*, $(C_6H_4CH_3)_2N{\cdot}N(C_6H_4CH_3)_2$, prepared from di-*p*-tolylamine, crystallises in large, pale yellow monoclinic prisms or tables, m. p. 138°. It is easily soluble in benzene, acetone, and chloroform, and dissolves in cold concentrated sulphuric acid, giving a brilliant, azure blue solution.

122. "The action of certain acidic oxides on salts of hydroxy-acids. Part II." By G. G. Henderson, D.Sc., M.A., and David Prentice.

The action of antimonious and arsenious oxides upon salts of citric, malic, lactic, and mucic acids has been studied, and several new salts have been prepared, the oxide being heated with solutions of salts of those acids for varying periods, and the compounds formed precipitated by alcohol or separated by crystallisation.

With citrates of potassium, sodium and ammonium, antimonious oxide gave compounds of the general formula $SbOM'_3(C_6H_6O_7)_2{\cdot}xH_2O$, which are all crystalline and readily soluble in water. A sparingly soluble barium salt, $SbOBa_3(C_6H_6O_7)_3{\cdot}10H_2O$, was obtained by precipitation, and from it a very soluble crystalline compound of the probable formula $OH{\cdot}Sb\therefore(C_6H_7O_7)_2$ was prepared. Arsenious oxide gave similar compounds with citrates of the alkalis. They have the general formula $AsOM'_3(C_6H_6O_7)_2{\cdot}xH_2O$, are crystalline, and dissolve freely in water.

Both antimonious and arsenious oxides dissolve in boiling aqueous solutions of alkaline malates. A well crystallised antimony compound, whose simplest formula is $(SbO)_3K_4H(C_4H_5O_5)_6{\cdot}3H_2O$, was prepared, but no corresponding arsenic compounds have yet been obtained, owing to their instability.

Boiling solutions of lactates of the alkalis and of barium readily dissolve both antimonious and arsenious oxides, and alcohol precipitates colourless syrups, containing large quantities of unaltered lactates.

Compounds of the oxides with mucates were also prepared, though with some difficulty. Two antimony compounds of the formulæ $2SbOKC_6H_8O_8{\cdot}KC_6H_9O_8{\cdot}6H_2O$ and $SbOKC_6H_8O_8{\cdot}4H_2O$ were obtained in the form of sparingly soluble crystalline powders. An arsenic compound corresponding to the second of these was likewise obtained.

These substances might be regarded as double citrates, malates, &c., containing the radicles $(SbO)'$ and $(AsO)'$, but, if so, then in all probability those radicles replace the hydrogen of alcoholic hydroxyl groups, and not the hydrogen of carboxyl groups as in the formation of salts, for otherwise it is difficult to understand why hydroxy-acids alone seem to have the power of forming such compounds. On the other hand, they might be regarded as salts of acids derived from antimonious or arsenious acids by replacement of two of the hydroxyl groups of those acids by organic acid radicles, as is the case with the antimonio- and arsenio-tartrates. The formulæ of such acids would be, for antimonio-citric acid $OH\cdot Sb\vdots(C_6H_7O_7)_2$, for antimonio-malic acid $OH\cdot Sb\vdots(C_4H_5O_5)_2$, for antimonio-mucic acid, $OH\cdot Sb\vdots C_6H_6O_5$; the formulæ of the arsenious acid derivatives would be similar to these. In the case of some at least of the new compounds this view appears preferable.

123. "Sodium nitrososulphate." By E. Divers, F.R.S., and T. Haga.

Sodium nitrososulphate, being a very soluble salt, does not crystallise out when even the strongest solution of sodium sulphite is treated with nitric oxide. But if the solution, after this treatment has been continued long enough, be deprived of most of its sodium sulphate by freezing out, and be then evaporated in a vacuum to a very small volume, sodium nitrososulphate is deposited in crystals.

It is an anhydrous salt, forming very minute crystals, which in the solution adhere together in opaque crusts. The salt is slightly alkaline to litmus, and tastes much like common salt. It is exceedingly soluble in water and very unstable, wet or dry. In the dry state, in which it can be obtained in a desiccator, and at the common temperature, it rapidly decomposes on exposure to (damp) air, becomes nearly as hot as slaking lime, and gives off large quantities of nitrous and nitric oxides. The residue consists of sodium sulphate and sulphite. It thus behaves at the common temperature as potassium nitrososulphate only does when heated to about 100°.

In solution in water it continuously decomposes, like the potassium salt, into sulphate and nitrous oxide. A little sodium hydroxide greatly retards this decomposition in water, but if a solution of the salt containing sodium hydroxide is heated to boiling, the salt decomposes freely into nitric oxide and sulphite. This behaviour is unlike that of the potassium salt.

Its composition, which was indirectly determined quantitatively, is $Na\cdot ON{:}NO\cdot SO_3Na$.

124. "The constitution of nitrososulphates." By E. Divers, F.R.S., and T. Haga.

Potassium nitrososulphate in aqueous solution becomes strongly alkaline when mixed with a little alcohol. This is due to the salt and the alcohol partly decomposing into potassium ethyl sulphate, nitrous oxide, and potassium hydroxide. The primary reaction is, beyond a doubt, one in which potassium hydrogen hyponitrite is produced, along with the potassium ethyl sulphate, although none can be detected; but then its formation proceeds here very slowly, and certainly not faster than it is known to decompose of itself into potassium hydroxide and nitrous oxide.

This reaction is peculiarly interesting, for in it alcohol decomposes a sulphate in alkaline solution, and liberates potassium hydroxide, though indirectly. The occurrence of this reaction, taken with other properties, solves the problem of the constitution of the nitrososulphates. They are anhydro-double salts of hyponitrous and sulphuric acids, which hydrolyse into the acid salts of these acids, the the acid salts simultaneously changing into normal sulphate, nitrous oxide, and water. They are analogous to the thiosulphates, the hyponitrite radicle acting as sulphur does in them. Thus we see calcium thiosulphate and sodium nitrososulphate forming themselves from the sulphite of their metal and decomposing into it again, under precisely similar conditions. Nitrososulphates are, however, true sulphates, as their reactions with alcohol and with acidified barium chloride show, their nitrogen being united to their sulphur only though an atom of oxygen, $KON_2{\cdot}O{\cdot}SO_3K$.

125. "Normal hexane from light petroleum (petroleum ether)." By G. L. Thomas, B.Sc., and Sydney Young, D.Sc., F.R.S.

Having devised an improved form of dephlegmator (*Chem. News*, **71**, 177) we determined to attempt the separation of a pure paraffin from "petroleum ether" in the same way that ethyl acetate was separated from a mixture of methyl, ethyl, and propyl acetates (*Phil. Mag.*, 1894, 8).

Each fraction was weighed, and its temperature range noted and corrected for the thermometric error and for the difference between the barometric reading and 760 mm. The ratio of the weight of any fraction (Δw) to its temperature range (Δt) gives, as a rule, a measure of the purity of the liquid, though in the early fractionations of a complex mixture this cannot be relied on.

Thus, in the 4th fractionation the fraction coming over between 65·0° and 66·0° had the highest value of $\Delta w/\Delta t$, whereas in the 16th fractionation the corresponding fraction (65·0° to 66·85°) had the lowest value. At an early stage of the work it appeared, therefore, as though a single substance boiling at about 65° or 66° was being separated from liquids boiling at much higher and lower temperatures (above 90° and below 40°); but the later fractionations showed that instead of a single substance boiling at about 65° or 66°, there were really two liquids—one boiling at 69°, and the other at about 61° (normal and iso-hexane).

As the number of fractions was very large, it was decided after the 16th fractionation to proceed only with the separation of normal hexane, and after 31 preliminary fractionations it was considered that the separation had proceeded far enough for the final series of fractionations to be undertaken, as in the case of ethyl acetate (*loc. cit.*). The hexane obtained by the final fractionation of the fractions boiling at and above 69·05°, when distilled from phosphorus pentoxide, boiled at 69·1°, or only 0·1° higher than the hexane prepared from propyl-iodide, but its sp. gr. at 0° (0·68478) was 1·15 per cent. higher. The hexane was then treated with a mixture of concentrated sulphuric and nitric acids, when considerable heat was evolved, and the acid became yellow, and was found to contain some *m*-dinitrobenzene in solution. The impurity present was therefore benzene or possibly hexanaphthene, or both.

The remaining high boiling fractions were treated with the mixed acids and were refractionated; the low boiling fractions also were treated in the same manner before their final fractionation, and in every case it was found that *m*-dinitrobenzene was formed.

By further long continued treatment of the two specimens of hexane with the mixed acids and subsequent distillation, a quantity was finally obtained boiling at 69·05° and with the sp. gr. 0·67813 at 0°, or only 0·17 per cent. higher than that of pure hexane.

The vapour pressures and specific volumes—as liquid and as saturated vapour—were determined at a few temperatures, and the critical temperature and pressure were also observed; the results differed but slightly from those obtained with the hexane from propyl iodide. The critical constants of both specimens are given below.

	Critical temperature.	Critical pressure.
Hexane from petroleum ether....	235·15°	22560
Hexane from propyl iodide......	234·8	22510

The hexane was evidently very nearly pure, but the separation of this paraffin from petroleum ether is only possible by long continued fractional distillation with an efficient dephlegmator, and by removal of benzene or hexanaphthene with nitric and sulphuric acids.

126. "The vapour pressures, specific volumes, and critical constants of normal hexane." By G. L. Thomas, B.Sc., and Sydney Young, D.Sc., F.R.S.

The normal hexane employed was obtained from Kahlbaum and prepared by the action of sodium on propyl iodide. It was purified by treatment with concentrated nitric and sulphuric acids and subsequent fractional distillation.

The boiling point at 760 mm. is 69·0°, and the specific gravity at 0° is 0·67696. The critical constants are,

Critical temperature.......	234·8°
Critical pressure..........	22510 mm.
Critical volume of a gram ..	4·268 c.c.

The vapour pressures and the volumes of a gram—as liquid and as saturated vapour—were determined, and a limited number of observations of pressure and volume of unsaturated vapour were made at a series of temperatures with the object of finding whether the isochors showed any indication of curvature. As in the case of isopentane (in about the same volume region) the isochors were found to be very slightly curved, the values of dp/dt diminishing with rise of temperature. The deviations from constancy become smaller as the volume increases.

The absolute temperatures and molecular volumes of liquid and saturated vapour were read from the curves at a series of pressures "corresponding" to those given in previous papers, and the ratios of the absolute temperatures and of the volumes to the critical constants were calculated. These ratios agree with those of isopentane and benzene; normal hexane therefore belongs to Group I in the classification of substances previously adopted (Trans., **63**, 1257; *Phil. Mag.*, 1894, 1), and the molecules of the liquid are probably simple like those of the gas.

The absolute temperature ratios at corresponding pressures are higher for hexane than for isopentane; in this respect the paraffins seem to resemble the esters (Trans., **63**, 1252), for which the ratios increase without exception with rise of molecular weight. In the case of the esters, the volume ratios appear to be independent of molecular weight, but—for isomeric compounds—to depend to some extent on the constitution. It seems probable that this may also be the case for the two paraffins studied, but an investigation of other paraffins will be necessary before these points can be decided.

The ratio of the actual to the theoretical density at the critical point is 3·83, the mean value for the other members of Group I, including carbon dioxide (Amagat) and isopentane being 3·75.

127. "Acidylthiocarbimides." By Augustus E. Dixon, M.D.

This paper gives an account of further experiments (see Dixon and Doran, Trans., 1895, **67**, 565) on the production of thiocarbimides containing acidic radicles. By heating the chloride of valerianic or of cinnamic acid with lead thiocyanate in presence of anhydrous benzene, valeryl or cinnamoyl thiocarbimide is formed, and passes into solution. Both these thiocarbimides have a slightly pungent odour, and attack the eyes, causing a flow of tears, the former being especially active. They are readily desulphurised by lead or silver salts, but decompose in presence of water, yielding thiocyanic acid, together with the acid characteristic of the thiocarbimide, Ph·CH:CH·CO·NCS + H_2O = HSCN + PhCH:CH·COOH. By bringing the solutions into contact with ammonia, amines, or ethyl alcohol, the corresponding thioureas, thiocarbamides, or thiourethanes, respectively, are produced.

The following compounds are described:

ab-*Valerylphenylthiocarbamide*, BuCO·NH·CS·NHPh; sym. *valerylphenylurea*, BuCO·NH·CO·NHPh; ab-*valerylorthotolylthiocarbamide*, BuCO·NH·CS·NH-*o*-To; sym. *valerylorthotolylurea*; ab-*valerylparatolylthiocarbamide*, BuCO·NH·CS·NH-*p*-To; *valeryl-α-naphthylthiocarbamide*, BuCO·NH·CS·NH·αNapt; n-*valeryl-ν-benzylphenylthiourea*, $PhCH_2·N(Ph)·C(SH):N·COBu$; *valerylthiourea*, $CSN_2H_3·COBu$; *valeryl-β-thiourethane*, $BuCO·NH·CS·OC_2H_5$; ab-*cinnamoylphenylthiocarbamide*, PhCH:CH·CO·NH·CS·NHPh; ab-*cinnamoylorthotolylthiocarbamide*, PhCH:CH·CO·NH·CS·NH-*o*-To; ab-*cinnamoylparatolylthiocarbamide*, PhCH:CH·CO·NH·CS·NH-*p*-To; ab-*cinnamoylalphanaphthylthiocarbamide*, PhCH:CH·CO·NH·CS·NHαNapt; *cinnamoylthiourea*, $CSN_2H_3·COCH:CHPh$; $PhCH:CH·CO·NH·CS·OC_2H_5$, *cinnamoyl-β-thiourethane*. All the thioureas above-named, with the exception of the valerylbenzoylphenyl compound, are desulphurised by heating with alkaline lead tartrate.

It is proposed to extend these experiments with lead thiocyanate, in the hope of obtaining thiocarbamides derived from other acids than those only containing the group CO·Cl; for example, picric, phenylsulphonic, and ethylsulphuric acids.

128. "Some constituents of the root of 'Polygonum Cuspidatum.'"

By A. G. Perkin.

Polygonum cuspidatum is a native of China and Japan, and flourishes in parts of India and Russia. The freshly gathered roots consist of a thick, succulent bark of an orange-red colour, and a central, woody portion of a light yellow tint.

The principal constituent of the root bark was found to be a glucoside, $C_{21}H_{20}O_{10}$, crystallising in lustrous, yellow needles melting at 202—203°. On hydrolysis, this yielded 61·82 per cent. of a product which was recognised as *emodin*, the reaction $C_{21}H_{20}O_{10} + H_2O = C_{15}H_{10}O_5 + C_6H_{12}O_6$ requiring 62·5 per cent. of emodin. This glucoside, for which the name *cuspidatin* is proposed, differs considerably in properties from frangulin, $C_{21}H_{20}O_9$, the glucoside of emodin which is contained in the bark of the *Rhamnus frangula.*

A second glucoside was also isolated, but in too small quantity for analysis. On hydrolysis, it yielded a crystalline substance melting at 199°, which by treatment with sulphuric acid at 160° was converted into emodin. It was found to be identical with the emodin monomethyl ether previously isolated from the root bark of *Ventilago madraspatamæ* (Trans., 1894, 923). The other substances found were a small amount of free emodin and a wax which crystallised in colourless leaflets melting at 134—135°. This latter was found to be identical with the wax $C_{18}H_{28}O$, present in the root bark of the *Morinda umbellata* (Trans., 1894, 854).

An examination is being carried out of the constituents of the roots of the *Polygonum bistorta* and *Rumex nepalensis*, which are closely allied to this plant.

129. "Note on the action of hydrofluoric acid upon crystallised silicon." By G. S. Newth.

It is generally stated that hydrofluoric acid is without action upon crystallised silicon: that while amorphous silicon is attacked by it, this acid is incapable of acting upon the crystallised element.

This statement, however, requires to be made with some reservation, for although it is doubtless true of the aqueous acid, and possibly of the liquid acid, it is not true of the gas.

If acid potassium fluoride be heated in a platinum retort, and the pure gaseous hydrofluoric acid so produced be allowed whilst hot to blow upon a little heap of crystallised silicon supported on a porcelain crucible lid, the silicon at once takes fire and burns brilliantly in the gas, forming silicon fluoride and hydrogen.

If the neck of the retort be more than an inch or two in length, it is necessary to heat it in order to keep the gas sufficiently hot, but if it be quite short, the temperature of the gas as it is disengaged from its compound is sufficiently high to enable it to attack the silicon.

The importance of this observation lies in the fact that the spontaneous ignition of crystallised silicon is generally regarded as in all cases a sufficient test for free fluorine; but it is evident that unless the temperature of the gas is below a certain point the combustion of silicon is not a safe criterion.

130. "Note on the periodides of theobromine." By G. E. Shaw.

Apparently only one periodide of theobromine has been previously described, viz., that having the formula $C_7H_8N_4O_2\cdot HI\cdot I_3$, prepared by Jörgensen by exposing a solution of theobromine hydrochloride, mixed with potassium iodide, to the air. By varying the amounts of hydrochloric and hydriodic acids present, the author has obtained compounds having the formulæ $(C_7H_8N_4O_2)_2HI\cdot HCl\cdot I_2$ and

$$(C_7H_8N_4O_2)_3HI(HCl)_2I_3,$$

and by recrystallisation of a mixture of the three from weak alcohol containing hydriodic acid and iodine, a substance of the composition $(C_7H_8N_4O_2HI)I_2 + H_2O$ was obtained.

A solution of theobromine in saturated hydriodic acid deposited on standing crystals having the composition $(C_7H_8N_4O_2HI)_2I_3$.

131. "A synthesis of diphenyloxytriazoline." By George Young, Ph.D.

The reaction between benzaldehyde and phenylsemicarbazide described in a previous notice (Proc., 1894, 95, 124), and represented by the equation $C_7H_9N_3O + C_7H_6O + O = C_{14}H_{11}N_3O + 2H_2O$, is shown in the present paper to take place in the following two stages. I. $C_7H_9N_3O + O = C_7H_7N_3O + H_2O$; II. $C_7H_7N_3O + C_7H_6O = C_{14}H_{11}N_3O + H_2O$. The intermediate product, $C_7H_7N_3O$, is phenylazocarbonamide, $C_6H_5N{:}N\cdot CO\cdot NH_2$. It is formed immediately by the action of ferric chloride in aqueous solution, or potassium permanganate in dilute sulphuric acid. It is also formed, but very slowly, by the action of moist air on phenylsemicarbazide. It forms red needle-shaped crystals, m. p. 114°. The second stage of the above reaction does not take place so easily when the intermediate product is isolated as when the benzaldehyde is added to the phenylsemicarbazide before oxidation. In the latter case, the whole reaction takes place in boiling alcohol; in the former, the azo-derivative and the benzaldehyde require to be heated in alcohol in a sealed tube at 120° C. The benzoyl derivative, $C_{14}H_{10}N_3O(C_7H_5O)$, has been prepared, in addition to those previously mentioned, by the action of benzoyl chloride on diphenyloxytriazoline and its silver salt. It forms flat needles, m. p. 133·5°.

132. "Note on piperovatine." By Wyndham R. Dunstan, F.R.S., and Francis H. Carr.

The method previously used (Trans., 1895) for extracting piperovatine from *Piper ovatum* being exceedingly tedious, the authors experimented with the view of finding a better method. The following process is a considerable improvement, and with its aid the active constituent can now be extracted and crystallised in the course of a few hours. The method consists in percolating with ether; the dark-coloured extract thus obtained is freed from ether, and the adhering volatile oil, and then extracted with hot dilute alcohol (15 per cent.); on cooling this extract, crystals separate, which may be recrystallised from 40 per cent. alcohol.

Further experiments have been made on the hydrolysis of piperovatine with the small remaining quantity of material. A small quantity was heated with water in a sealed tube to 160°, with the result that a volatile base, probably a pyridine derivative, a substance smelling like anisol and giving phenol, on treatment with sodium hydroxide, and also an acid were produced.

133. "Dibenzaconine and tetracetylaconine." By Wyndham R. Dunstan, F.R.S., and Francis H. Carr.

The authors having failed so far to produce aconitine by the acetylation of benzaconine have tried to form benzaconine by introducing a benzoyl group into aconine; this, however, has not yet been contrived, but new aconine derivatives have been obtained. When equimolecular proportions of aconine and benzoic anhydride are dissolved together in chloroform and allowed to stand at the ordinary temperature, reaction occurs with production of dibenzaconine.

Dibenzaconine, $C_{24}H_{37}(Bz)_2NO_{10}$, is unlike aconine in being insoluble in water and soluble in ether; it crystallises from ether in rosettes of needles, m. p. 265°. *Dibenzaconine hydrobromide* crystallises well from a mixture of alcohol and ether, m. p. 261°. *Dibenzaconine aurichloride* is precipitated by adding a solution of gold chloride to a solution of the hydrochloride of the base, and may be crystallised in yellow tables from a mixture of alcohol, ether, and petroleum, m. p. 212°. This salt contained 18·2 per cent. of gold; calculated for $C_{24}H_{37}(Bz)_2NO_{10}HAuCl_4$, 18·71 per cent. Hydrolysis of the base furnished 33·3 per cent. of benzoic acid; the calculated quantity for $C_{24}H_{37}(Bz)_2NO_{10}$ is 34·4 per cent.

By the action of a large excess of benzoic anhydride, a crystalline base, m. p. 190°, soluble in ether and insoluble in water, is formed, which has not been further examined. Benzoyl chloride dissolved in chloroform does not react with aconine even when heated with the base.

Tetracetyl-aconine is formed when a solution of aconine hydrochloride and acetyl chloride in chloroform is allowed to stand for 36 hours at the ordinary temperature. It is insoluble in water, but readily soluble in ether and in alcohol, from either of which solvents it crystallises in small prisms, m. p. 196°.

On hydrolysis, aconine and 35·2 per cent. of acetic acid are formed, the formula $C_{24}H_{35}(Ac)_4NO_{10}$ demands 35·8 per cent. of acetic acid.

134. "Molecular volume change during the formation of dilute solutions in organic liquids." By A. Wentworth Jones, M.A.

The author has determined the volume changes during the formation of several solutions in benzene and carbon disulphide, and calculated the molecular volume change as $v \times m \times W/V \times M \times w = x$.

Where v = observed volume change,
V = volume of solution,
m = molecular weight of substance,
w = weight of substance taken,
W = ,, solvent ,,
M = molecular weight of solvent,
and x = ,, expansion or contraction.

The values for molecular weights of several "non-associating" liquids are very different, and sometimes change their sign, and if the phenomena of these solutions in organic liquids are comparable with those of aqueous solutions of organic compounds, it is impossible to admit that these volume changes are measurements of the attraction of substance for solvent and equal for molecular weights of different substances, as is stated by Traube (*Ber.*, 1895, **28**, 410).

The following values have been obtained by the use of the specific gravity method.

Carbon Disulphide Solutions at 15° C.

	Molecular expansion.
Methyl formate	0·0797
Ethyl acetate	0·0809
Ethyl acetoacetate	0·1072
Paraldehyde	0·0972
Nitrobenzene	0·0349
Benzaldehyde	0·0305
Aniline	0·0310
Benzene	0·0320
Ethyl iodide	−0·0632
Phosphorus trichloride.	−0·0913

A contraction occurs in the last two.

Benzene Solutions at 15° C.

	Molecular expansion.
Methyl formate......	0·0156
Ethyl acetate	0·0076
Ethyl acetoacetate ...	0·0120
Paraldehyde	0·0141
Nitrobenzene	−0·0040
Benzaldehyde	−0·0042
Aniline	−0·0067
Carbon disulphide ...	0·0188
Piperidine	0·0020
Phosphorus trichloride	0·0041

A contraction occurs in the 5th, 6th, and 7th cases.

The author suggests that these volume changes occurring on solution are of the same nature as the smaller changes occurring when a moderately strong solution is diluted, and that both are analogous to the deviations from Boyle's law observed in the case of gases.

ADDITIONS TO THE LIBRARY.

I. *Donations.*

Notes on the Chemistry of Iron. By Magnus Troilius, E.M. 8vo. Pp. vi+98. New York 1886. From B. H. Brough, Esq.

Notes on the Nebular Theory in relation to Stellar, Solar, Planetary, Cometary, and Geological Phenomena. By W. Ford Stanley, F.R.A.S., F.G.S., &c. 8vo. Pp. xv+259. London 1895. From the Author.

An Introduction to the Study of Rocks. Mineral Department, British Museum (Natural History). Printed by Order of the Trustees. From the Trustees.

The Glasgow University Calendar, for the year 1895–96. From the University.

Principles of Chemistry. By D. Mendeléeff. 6th Edition. 8vo. Pp. ix+780. From Prof. D. Mendeléeff.

Poisons: Their Effects and Detection. A Manual for the use of Analytical Chemists and Experts. By Alexander Wynter Blyth. 3rd Edition. Revised and Enlarged. 8vo. Pp. xxxii+724. London 1895. From the Author.

University College, Bristol. Calendar for the Session 1895-96. Bristol 1895. From the Council of the College.

Thirteenth Annual Report of the United States Geological Survey to the Secretary of the Interior, 1891–92. By J. W. Powell, Director. Part I. Report of the Director. Pp. vii+240. Part II. Accompanying Papers. Pp. xx+597. Maps. 8vo. Washington 1892. From the Survey.

Quantitative Chemical Analysis. Adapted for use in the Laboratories of Colleges and Schools. By Frank Clowes, D.Sc. Lond., and J. Bernard Coleman. 3rd Edition. Pp. xxiv+533. 8vo. London 1895.

Department of the Interior: Monographs of the United States Geological Survey. Vol. XXIII. Geology of the Green Mountains in Massachusetts. By R. Pumpelly, J. E. Wolff, and T. Nelson Dale. 4to. Pp. xiv+206. Washington 1894.

Department of the Interior. Monographs of the United States

Geological Survey. Vol. XXIV. Mollusca and Crustacea of the Miocene formations of New Jersey. By Robert Parr Whitfield. 4to. Pp. vi+195. Washington 1894.

Department of the Interior. Bulletin of the United States Geological Survey.

No. 118. A Geographic Dictionary of New Jersey. H. Gannet. 8vo. Pp. vi+131. Washington 1894.

No. 119. A Geological Reconnoissance in North-West Wyoming. G. H. Eldridge. 8vo. Pp. vi+72. Washington 1894.

No. 120. The Devonian System of Eastern Pennsylvania and New York. C. S. Prosser. 8vo. Pp. vi+81. Washington 1894.

No. 121. A Bibliography of North American Paleontology, 1888–1892. C. R. Keyes. 8vo. Pp. vi+251. Washington 1894.

No. 122. Results of Primary Triangulation. H. Garnett. 8vo. Pp. vi+412. Washington 1894.

From the Survey.

Journal and Proceedings of the Royal Society of New South Wales. Vol. XXVIII. 1894. Pp. xxv+368. 46 plates. 8vo. Sydney 1895.
From the Society.

Twenty-third Annual Report of the Local Government Board, 1893–94. Supplement containing the Report of the Medical Officer for 1893–94. Pp. xxxv+526. 8vo. London 1894.

From the Medical Officer.

Charter, Supplemental Charter, and Bye-laws, and List of Members of the Institution of Civil Engineers. Pp. 195. 8vo.

From the Institution.

Journal of the Iron and Steel Institute, 1895. I. Vol. XLVII. And Rules and List of Members of the Institute.

From the Institute.

I Consimi di Angiolo Funaro. 12mo. Pp. vii+253. Milano 1894.
From the Author.

Justus von Liebig, his Life and Work (1803–1873). By W. A. Shenstone, F.I.C. 8vo. Pp. vi+219. London 1895.

From the Author.

University College, Bristol. Calendar for the Session 1895–96. 8vo. Pp. 252. Bristol 1895.
From the College.

Twenty-third Annual Report of the Local Government Board, 1893–94. Supplement containing the Report of the Medical Officer for 1893–94. 8vo. Pp. xxxv+528.
From the Board.

The True Atomic Weights of the Chemical Elements and the Unity of Matter. By Gustavus Detlef Hinrichs, M.D., LL.D. 8vo. Pp. xiv+255.
From the Author.

The Rise and Development of Organic Chemistry. By Carl Schorlemmer, LL.D., F.R.S. Revised edition. Edited by Arthur Smithells, B.Sc. London 1894. 8vo. Pp. xxviii + 280, with portrait. From Professor Thorpe.

The Handling of Dangerous Goods: comprising Notes on the Properties of Inflammatory, Explosive, and other Dangerous Compounds, and the modes of storage and transport thereof, with official classifications, parliamentary enactments, particulars of recorded accidents, &c. By H. Joshua Phillips. London 1896. 8vo. Pp. xii + 362. From the Publishers.

Agricultural Investigations at Rothamstead during a period of fifty years, being six Lectures delivered under the auspices of the Association of American Agricultural Colleges and Experimental Stations in November, 1893, by Sir Joseph Henry Gilbert, M.A., LL.D., F.R.S. (Bull. 22, U.S. Department of Agriculture). Washington 1895. 8vo. Pp. 316. Portrait and two folding diagrams. From the Author.

Carl Wilhelm Scheele. Nachgelassene Briefe u. Aufzeichungen: herausgegeben von A. E. Nordenskiöld. Stockholm 1892. 8vo. Pp. xliv + 492 + 2 pp. facsimile.

MS. Notes of Courses of Lectures delivered at the Royal Institution during the years 1833–37 by Faraday, Brande, and others, with some later notes. 4to. Pp. 542 + 8 pp. index. Presented by Mr. E. Ivens Moon.

II. *By Purchase.*

A Dictionary of Explosives (Second Edition). By Lieut.-Col. J. P. Cundill, R.A. Entirely Re-arranged and brought up to date by Captain J. H. Thomson, R.A. 8vo. Pp. xliv + 183. London 1895.

Die neueren Arzneimittel in ihrer Anwendung und Wirkung dargestellt. Von Dr. W. F. Loebisch. 8vo. Pp. viii + 416. Wien und Leipzig 1895.

Die Methoden der Bakterien-Forschung. Handbuch der gesammten Methoden der Mikrobiologie. Von Dr. Ferdinand Hueppe. 8vo. Pp. viii + 495. Wiesbaden 1891.

Geschichte der Explosivstoffe. I. Geschichte der Sprengstoffchemie, der Sprengtechnik und des Torpedowesens bis zum Beginn der Neuesten Zeit. S. J. von Romocki. 8vo. Pp. viii + 395. Berlin 1895.

A Guide to Stereochemistry, based on Lectures delivered at Cornel. University, with an Index to the Literature and an Appendix, Models for use in Teaching Organic Chemistry. By Arnold Eiloart, Ph.D., B.Sc. Reprinted with additions from Scientitific Periodicals. Illustrated with 50 Woodcuts and five Plates. 8vo. Pp. ii + 96 + 6. New York and Halle.

An Introduction to the Study of Metallurgy. By W. C. Roberts-Austen, C.B., F.R.S. Third edition. Revised and Enlarged. 8vo. Pp. xvi + 379. London 1894.

Lehrbuch der Gerichtlichen Chemie mit Berüchsichtigung Sanitätspolizeilicher und Medicinisch-Chemischer untersuchungen zum Gebrauche bei Vorlesungen und im Laboratium. Bearbeitet von Dr. Georg Baumert. 8vo. Pp. xx + 422. Braunschweig 1889–1893.

An Introduction to Chemical Crystallography. By Andreas Fock, Ph.D. (Berlin). Translated and Edited by Wm. J. Pope, with a Preface by N. Story-Maskelyne, M.A., F.R.S. 8vo. Pp. xvi + 189. Oxford 1895.

Ausführliches Lehrbuch der Pharmaceutischen Chemie. Bearbeitet von Dr. Ernst Schmidt. Erster Band. Anorganische Chemie. Dritte vermehrte Auflage mit zahlreichen Holzstichen und einer fabrigen Spectraltafel. 8vo. Pp. xxiii + 1106. Braunschweig 1893.

Ostwald's Klassiker der exakten Wissenschaften, Nr. 66. Die Anfänge des Naturlichen Systemes der Chemischen Elemente. Abhandlungen von J. W. Doebereiner (1829) und Max. Pettenkofer (1850). 8vo. Pp. 34. Leipzig 1895.

A Manual of Microchemical Analysis. By Professor H. Behrens, with an Introductory Chapter by Professor J. W. Judd, F.R.S., with 84 Illustrations drawn by the Author. 8vo. Pp. xxv + 246. London 1894.

Kurzes Handbuch der Kohlenhydrate. Von Dr. B. Tollens. Zweiter Band. 8vo. Pp. xvi + 407. Breslau 1895.

Jahrbuch der Organischen Chemie: herausgegeben von Gaetano Minunni, Palermo. Erster Jahrgang 1893 mit einem Vorwort von Ernst von Meyer. Leipzig 1895. 8vo. Pp. xiv + 881. Two copies.

Mémoire sur la liquéfaction de l'oxygène, la liquéfaction et la solidification de l'hydrogéne et sur les théories des changements des corps. Par M. Raoul Pictet. Genève 1878. 8vo. Pp. 108. Three plates.

Die Industrie des Steinkohlentheers und Ammoniaks. Von Dr. Georg Lunge. Dritte Auflage. Braunschweig 1888. 8vo. Pp. xvi + 657.

A Text-book of the Science and Art of Bread-making, including the Chemistry and Analytic and Practical Testing of Wheat, Flour, and other materials employed in Baking. By W. Jago. London 1895. 8vo. Pp. xii + 648.

Chemical Analysis of Oils, Fats, and Waxes, and of the Commercial Products derived therefrom. From the German of Professor Dr. R.

Benedikt. Revised and enlarged by Dr. J. Lewkowitsch. London 1895. 8vo. Pp. xviii + 683.

Solution and Electrolysis. By W. C. D. Whetham, M.A. Cambridge, 1895. 8vo. Pp. viii + 296. (Cambridge Natural Science Manuals. Physical Series.)

COLLECTIVE INDEX OF THE TRANSACTIONS, ABSTRACTS, AND PROCEEDINGS OF THE CHEMICAL SOCIETY.

Volume II, 1873 to 1882. Volume III, 1883 to 1892.

The Council, having determined to publish a Collective Index of their publications from 1873 to 1892 inclusive, will issue copies to Fellows who may notify their wish to receive them. Both volumes will be sent to those who have been Members of the Society since the end of 1882. Volume III will be sent to Fellows who have joined the Society between 1st January, 1883 and 31st December, 1892. Fellows who are ineligible to receive gratis copies, and those who may have neglected to apply for them within the prescribed period, may obtain them by purchase at a price to be hereafter fixed. Fellows who desire the Index should notify their wish by letter, enclosing 1*s*. for cost of distribution, &c., to the Assistant-Secretary, Mr. Robert Steele, Chemical Society, Burlington House, W., before 31st December, 1895. For Fellows resident abroad, who should remit 2*s*., which may be paid along with their annual contribution, the time will be extended to 1st March, 1896.

RESEARCH FUND.

A meeting of the Research Fund Committee will be held in December. Applications for grants, accompanied by full particulars, should be sent to the Secretaries before December 11th.

At the next meeting on Thursday, November 21st, the following papers will be read :—

"The evolution of carbon monoxide by alkaline pyrogallol solutions during absorption of oxygen." By Professor Clowes.

"The composition of the limiting explosive mixtures of various combustible gases with air." By Professor Clowes.

"Barium butyrate and the estimation of butyric acid." By W. H. Wilcox, B.Sc.

"On some derivatives of anthraquinone." By Dr. E. Schunck, F.R.S., and Dr. L. Marchlewski.

CERTIFICATES OF CANDIDATES FOR ELECTION AT THE NEXT BALLOT.

N.B.—The names of those who sign from "General Knowledge" are printed in *italics.*

The following Candidates will be balloted for on Thursday, December 5th, 1895:—

Bailey, George Percy,

7, Mount Pleasant Square, Dublin.

Chemical Demonstrator. Senior Moderator, B.A. in Experimental Science of Dublin University; now engaged in chemical investigation at above University, and also as extra assistant to Professor of Chemistry; late Science Master at Lucton School, Herefordshire.

J. Emerson Reynolds. Emil A. Werner.
W. E. Adeney. William A. Tilden.
Charles A. Kohn.

Berkeley, the Earl of,

Boars Hill, Abingdon, Oxfordshire.

Occupied in scientific research. Has studied Chemistry and Geology at the Royal College of Science, and is working especially on the density and crystalline forms of related salts in the laboratory, Christ Church, Oxford.

A. Vernon Harcourt. T. E. Thorpe.
W. Palmer Wynne. Wyndham R. Dunstan.
John M. Thomson.

Chapman, Arthur Jenner,

Burleigh House, Yerbury Road, Upper Holloway, N.

Analytical Chemist. Four years at Finsbury Technical College, and now engaged as Chemical Assistant in the Laboratory of the London County Council.

R. Meldola. W. J. Dibdin.
R. Grimwood. E. J. Parry.
J. H. Coste.

Chattaway, Wm.,

Apothecaries' Hall, London, E.C.

Chemist and Superintendent of the Society of Apothecaries. Public Analyst for the Borough of Colchester and the Parish of Hammersmith. Fellow of the Institute of Chemistry, Member of the Society of Public Analysts.

Frank L. Teed.	Edward Bevan.
Chas. Fred. Cross.	Leonard Temple Thorne.
C. G. Moor.	Alfred H. Allen.

Cockburn, George Bertram,

St. George's Hospital, Hyde Park Corner, S.W.

Demonstrator of Chemistry. Studied Chemistry at New College, Oxford, and graduated in Chemistry, taking Honours in the Final School of Natural Science. At present Demonstrator in the Chemical Laboratories at St. George's Hospital.

W. W. Fisher.	John Watts.
J. Addyman Gardner.	J. E. Marsh.
V. H. Veley.	Chas. Slater.

Crocker, Charles,

St. Peter's Road, Cockett, Swansea.

Analytical Chemist and Assayer. Analytical Chemist and Assayer, Gas Analyst to the County Borough of Swansea; Science Teacher (Honours) under the South Kensington Science and Art Department. For 16 years chief Assistant to the late Dr. W. Morgan, F.I.C., F.C.S., and at present chief Assistant to Messrs. W. Morgan, Son, and Seyler, Technical Institute, Swansea.

Christopher James.	Geo. L. Thompson.
W. Terrill.	*William Crookes.*

William Ramsay.

Cuthbertson, Gurney,

69, Shoreham Street, Sheffield.

Superintendent of (for Messrs. Lewis, Berger, and Sons, Limited) the Lead Works, Sheffield. Matriculated London University, January, 1890. Studied at University College of Wales, Aberystwyth, and in the laboratories of Messrs. Wren and Gurney. For three years Assistant in the Laboratory of Messrs. Lewis, Berger, and Sons, Limited, Manufacturers of colours, paints, &c., and at present engaged in their Sheffield Works as above.

William Thorp.	Bernard Dyer.
John Spiller.	Frederic Jas. M. Page.

Frank Clowes.

Dixon, William,

102, Spring Street, Bury, Lancashire.

Science Master. Head of Chemistry and Physical Departments, Municipal Technical School, Bury. Member of the Society of Chemical Industry. Sixteen years' experience as Lecturer and Demonstrator in Chemistry and Physics. Educated at the Royal College of Science, South Kensington, London, during 1877–8–9, and for several years at Owens College, Manchester.

E. Frankland.
G. S. Newth.
H. E. Roscoe.
T. E. Thorpe.
W. Palmer Wynne.
H. B. Dixon.
Jas. Grant.

Farr, Edward Henry,

Uckfield.

Pharmaceutical Chemist. Teacher of Chemistry at Uckfield Grammar School (Organised Science School). Pharmaceutical Councils' Silver Medal for Practical Chemistry, 1885; 1885—1887 Chemist to Messrs. Wright, Layman, and Umney, Wholesale and Manufacturing Chemists, London. 1886—1894. Original Work On "Daphnidium Cubeba;" in 1886 Joint Paper (see *Year-Book of Pharmacy*), Braithwaite and Farr; 15 Original Papers (Farr and Wright) on Alkaloïdal Drugs, their Standardisation and Estimation by Gravimetric and Volumetric Methods (see *Pharm. Journal*, *Chemist and Druggist*, *and Year-Book of Pharmacy*, 1890 to 1894).

Wyndham R. Dunstan.
M. Carteighe.
Chas. Umney.
John Attfield.
Alfred H. Allen.
W. A. H. Naylor.

Fauvel, Charles James,

The Laboratory, Cranford, Middlesex.

Mining and Metallurgical Engineer and Assayer. Formerly of the Cape University. Ten years engaged in Metallurgical and Mineralogical Research in connection with the recovery of Gold from its ores, and in the application of Chemistry to Mining and Metallurgy. Member of the Institute of Mining and Metallurgy, &c.

P. Gerald Sanford.
D. A. Louis.
W. C. Roberts Austen.
H. Bailey.
Arnold Philip.
Frederic Jas. M. Page.
S. Herbert Cox.

Fielding, Patrick Joseph D.,

8, St. Joseph's Place, Cork.

Pharmaceutical Chemist. Member of the Pharmaceutical Society.

Fifteen years with the firm of Messrs. Harrington, Cork. Member of Society of Arts. Chemical education at Queen's College, Cork, under Professor Maxwell Simpson.

William B. Harrington.	Henry V. Alford, M.D., Lond.
Thomas Farrington.	Eugene MacSwiney.
Chas. R. C. Tichborne.	Edward Whitley Allson.
Patk. T. O'Sullivan, M.S., B.Ch.	Daniel J. O. Mahony.
Maxwell Simpson.	A. E. Dixon.
R. E. Doran.	H. N. B. Richardson, B.A.

J. Emerson Reynolds.

Foakes, Jervis E.,

Medical School, Caxton Street, Westminster.

Analytical Chemist. Chief Assistant to Dr. Dupré, F.R.S. *In Chemistry:* Has worked nearly 8 years with Dr. Dupré, F.R.S., latterly Chief Assistant. Has been employed by the Medical Department of the Local Government Board to assist Dr. Dupré in a research on Micro-organisms. Previously studied Chemistry at King's College, London, under Professor Bloxam and Professor Thomson. *In Engineering:* Has studied Mechanical and Electrical Engineering for 6 months with Professor Ayrton, F.R.S., and Professor Perry, F.R.S. Has served a 3 years' apprenticeship in Mechanical and Electrical Engineering at Messrs. Henley's Telegraph Works, North Woolwich. Has worked with Mr. D. K. Clark, M.I.C.E., 1 year, experimenting on Sewage, with machinery of which Mr. Clark and he were joint inventors and patentees.

A. Dupré.	H. Sprengel.	John M. Thomson.
H. Wilson Hake.	Otto Hehner.	*W. J. Dibdin.*

Fox, Stanley,

23, South Road, Faversham, Kent.

Chemical Analyst to the Cotton Powder Company, Limited, Faversham. Two years studied Chemistry and Practical Chemistry in the School of the Pharmaceutical Society, and afterwards worked during one session in the Research Laboratory of the Pharmaceutical Society.

Wyndham R. Dunstan.	John Attfield.
M. Carteighe.	G. French.
P. Gerald Sanford.	E. F. Harrison.

Gardner, James,

80, Heaton Terrace, Middleton, near Manchester.

Manufacturing Chemist. Three years Assistant Chemist to Messrs. S. Schwabe & Co., Calico Printers, &c., Rhodes, near Manchester. Articles (three years). Served under Mr. Estcourt, F.C.S., F.I.C., City Analyst for Manchester, and Analyst for Lancaster, Oldham, &c. Three years Chemist to Messrs. J. F. Hill & Co., Calico Printers, &c., Bowker Bank Print Works, Manchester.

Charles Estcourt. T. Haverson Estcourt.
C. Harry Bowes. C. Francis Young.
George H. Hurst. *Wm. T. Thompson.*

Graham, Edward,

Dalton Hall, Manchester.

Research Student in Chemistry. Four years in Chemical Laboratories of the Owens College. B.Sc. with Honours in Chemistry, Victoria University. During past session has conducted a research "On the Duration of the Flame of Explosions" under Professor Dixon.

Harold B. Dixon. Arthur Harden.
W. H. Perkin, jun. Gilbert J. Fowler.
P. J. Hartog.

Grossmann, Edward Henry,

12, Alfred Place West, S.W.

Assistant to Dr. Hake at the Westminster Hospital Medical School. Associate of the Royal College of Science, London. One year and 8 months with Dr. Hake as above.

H. Wilson Hake. A. Dupré. Wm. Macnab.
Chapman Jones. William Tate. *Otto Hehner.*
William A. Tilden.

Hall, Henry Arthur (The Rev.) M.A.,

The Schoolhouse, Totnes.

Teacher in Science, under the Technical Committee of the Devon County Council, and Head Master of Totnes Grammar School. Student at the Chemical Laboratory, Oxford. Science Master, St. Edward's School, Oxford. Local Lecturer in Theoretical and Practical Chemistry, under the auspices of the Devon County Council. Science Master at Totnes School.

V. H. Veley. W. W. Fisher. John Watts.
H. T. Gerrans. *J. E. Marsh.*

Hanes, Edgar Septimus,

108, Alexandra Road, St. John's Wood.

Lecture Demonstrator, Clifton College, Clifton, Bristol. Associate of the Institute of Chemistry. Joint author of paper on "Azo-compounds of the Ortho-series." Part III (*Trans. of Chem. Soc.*, 1894).

R. Meldola.
Charles R. Beck.
Gerald T. Moody.
W. A. Shenstone.
R. C. T. Evans.
Martin O. Forster.
William J. Pope.

Harrison, C. E.,

53, Lansdowne Road, W.

Analytical Chemist. Passed special examination in Chemistry for degree of B.A., 1st class, 1892, having attended lectures and practical classes at Caius College, and University Laboratories, Cambridge, 1889–92. Articled pupil to Dr. A. Dupré, F.R.S., January, 1892—January, 1895.

A. Dupré.
Wm. Macnab.
Otto Hehner.
H. Wilson Hake.
W. Kellner.
William A. Tilden.
Chapman Jones.

Henderson, James,

193, Blackness Road, Dundee.

Research Student, University College, Dundee. B.Sc., St. Andrew's University. Author of the following papers:—In conjunction with Professor Walker, D.Sc., Ph.D., &c. (*a.*) "Halogen Estimation in Organic Compounds" (*Chem. News*, 1895, **71**, No. 1840). (*b.*) "Electrolysis of Potassium Allo-ethylic Camphorate" (*J. Chem. Soc.*, 1895, **40**, 337); also in conjunction with Professor Frankland, F.R.S., B.Sc., Ph.D. (*c.*) "Some Ethereal Derivatives of Sarcolactic acid" (Proceedings of the Chemical Society, 1895, No. 150, 54; Forster Research Scholar, University College, Dundee, 1893–94.

James Walker.
Percy F. Frankland.
Frank W. Young.
Thomas Purdie.
Fred. J. Hambly.
James R. Appleyard.

Heriot, Thomas Hawkins Percy,

23, Wolseley Road, Crouch End, N.

Analytical Chemist. Two years articled pupil to Mr. R. H. Harland, 37, Lombard Street, and subsequently for 6 years his assistant. At present engaged as analyst to Messrs. Welford and Sons, Limited.

R. H. Harland.
Fredk. J. Lloyd.
Otto Hehner.
J. Parry Laws.
Bernard Dyer.

Hillard, Frederick Arthur,

1, Upper Tichborne Street, Leicester.

Schoolmaster, B.A., Oxford (2nd class Nat. Sc. Honour Schools, 1894), Int. B.Sc. London, 1893. Head Master of Science Department Wyggeston Schools, Leicester. Lecturer in Chemistry, Wool-Dyeing, and General Biology in the Leicester Technical Schools.

V. H. Veley. W. W. Fisher. John Watts.
J. E. Marsh. J. A. Gardner.

Holme, Arthur Edward, M.A., Oxon,

3, Ash Terrace, Saville Town, Dewsbury.

Schoolmaster. Educated at Manchester Grammar School. Open Scholar, Wadham College, 1877. Graduated B.A. First Class Honours Mathematics, 1880; First Class Honours Natural Science, 1882. Proxime Accessit Junior University Mathematical Scholarship 1879. Mathematical and Science Master, Manchester Grammar School, 1882–87. Chief Physics Master, 1888–89. Head Master Dewsbury Grammar School, and Chief Teacher of Chemistry therein. 1880–95.

Francis Jones. R. L. Taylor. C. L. Barnes.
Julius R. Cohen. Arthur Smithells.

James, Alfred,

18, St. Andrew's Drive, Pollockshields, N.B.

Metallurgical Chemist. For some years Chief Chemist, and now Technical Manager to the Cassel G. L. Co. Limited. Has been engaged on the Electrolysis of Chloride Solutions, the exploitation of the Cyanide process for dissolving Gold from Ores, and on the manufacture of Cyanides by fixation of Atmospheric Nitrogen.

A. K. Huntington. Walter G. McMillan.
James Mactear. John J. Beringer.
John S. MacArthur. George Beilby.
Cornelius Beringer. *R. R. Tatlock.*
Edmund J. Mills.

Johnson, Frederick Edward,

16, Stanley Terrace, West Park, Hull.

Director of and Chemist to E. and H. Allison, Limited, Manufacturing Chemists, Hull, student with James Baynes, Esq., and G. Carr Robinson, Esq., of Hull, and of Professors Attfield, Bentley, Dunstan, and Redwood, in London. Associate of the Pharmaceutical Society, and Member of the Pharmaceutical Society of N.S.W.

John Attfield. G. Carr Robinson.
Jas. Baynes. Wyndham R. Dunstan.
Thos. Tyrer.

Kibble, William Oakes, A.I.C.,

Norton Villa, Buckhurst Hill, Essex.

Chemist. Certificated student (3 years' course) Finsbury Technical College. Chemist to Messrs. W. J. Fraser and Co., Chemical Engineers; New Explosives Company, Stowmarket; Messrs. Fowler Brothers, Limited, Sugar Refiners.

R. Meldola.	Bernard Dyer.
B. E. R. Newlands.	Arthur B. Ling.
Julian L. Baker.	P. Gerald Sanford.

John A. R. Newlands.

Kinnicutt, Leonard P.,

Worcester, Mass., U.S.A.

Professor of Chemistry, Worcester Polytechnic Institute, Worcester, U.S.A. S. B. (M. I. T.) 1875. V. S. D. (HAR). 1875.—"Anthracene Pressings." [Graduating Thesis.] Abstract in *Prest's Rep.*, 1875, 142. 1878.—(With R. Anschütz.) "Ein Versuch zur Darstellung der Phenylglycerinsäure" (*Ber. d. Chem. Gesell*, 1878, 1219). (With same.) "Addition von Bromwasserstoff mittelst einer Lösung von Bromwasserstoff in Eisessig" (*Id.*, 1878, 1221). 1879.—(With same.) "Synthese der Phenylglycerinsäure oder Stycerinsäure" (*Id.*, 1879, 537). 1881.—"An Indirect Determination of Chlorine and Bromine by Electrolysis" (*Proc. Am. Acad.*, **17**, 91—93). 1882.—"The Decomposition of Phenyltribrompropionic Acid by Water" (*Amer. Chem. J.*, **4**, 25). 1883.—"Modification of Noack's Method of Preparing Carbonic Oxide" (*Id.*, **5**, 43). (With J. U. Nef.) "The Volumetric Determination of Combined Nitrous Acid" (*Proc. Am. Acad.*, **18**, 275—276). (With G. M. Palmer.) "The β-Phenyltribrompropionic Acid" (*Id.*, **18**, 277—281; *Amer. Chem. J.*, **5**, 383). "Rex Magnus" (*Science*, **2**, 345). "Determination of Combined Nitrous Acid" (*Amer. Chem. J.*, **5**, 388). 1884.—"Report on the Meteoric Iron from the Altar Mounds in the Little Miami Valley, Ohio" (*Seventeenth Rep. Peabody Museum*, 381—384). 1885.—(With R. C. Sweetser.) "Remarks on Schulze's Process for the Quantitative Determination of the Halogens in Aromatic Compounds" (*Amer. Chem. J.*, **6**, 415—416). 1887.—"Disposal of the Sewage of the City of Worcester" (*City Engineer's Report*). Reprinted. Pph. 8vo., pp. 9.

P. Philips Bedson.	F. R. Japp.
Wolcott Gibbs.	Charles E. Munroe.
Henry E. Roscoe.	*Frederic P. Dewey.*

Saville Shaw.

Mansfield, Walter,

Trafalgar House, Broughton, Manchester.

Experimental Chemist and Gas and Chemical Engineer. Studied Chemistry at Manchester Grammar School, Owens College, and in Berlin, Moscow, and Vienna. At present engaged as Research Chemist and partner in the firm of Edwin Mansfield & Sons, Gas Engineers, of Manchester, London, Madras, and Calcutta. Inventor of Plant for making Gas from sawdust, nut shells, sunflower seed shells and all kinds of mineral, animal, and vegetable matter. Designer of apparatus for use in Indian Government Colleges of Science.

George J. Allen.	Arthur H. Green.
H. Follows.	A. B. Griffiths.

Rowland Williams.

Massey, Cecil,

Lyndon House, Lenton Boulevard, Nottingham.

Analytical and Agricultural Chemist. Author of papers "On the Composition of certain Soils of South India" (*Chem. News*, **71**, 261), and other papers in course of publication. Joint author, with Dr. A. B. Griffiths, of a paper, "Sur une Leucomaïne extraite des Urines dans l'Angina pectoris" (*Comptes Rendus de l'Académie des Sciences*, Paris, Tome **120**; and *Chem. News*, **71**, 282). At present time engaged in research work.

H. Follows.	A. B. Griffiths.
Alexander Hay.	Robert H. Wilson.
Frank Clowes.	J. B. Coleman.
William Crookes.	*James Dewar.*
E. Frankland.	*Playfair.*

McCreath, James,

Agricultural Laboratory, 4, Lombard Court, E.C.

Analytical Chemist. Studied Chemistry in Glasgow with Messrs. Tatlock, Readman, and Thomson. Assistant to Mr. F. J. Lloyd, carrying out for him the Investigations into the Chemistry and Bacteriology of Cheddar Cheese-making. Obtained Scholarship, Royal Agricultural Society, and holds 1st Class Certificate Highland and Agricultural Society.

Fredk. J. Lloyd.	R. R. Tatlock.
Horatio Ballantyne.	C. M. Aikman.
J. Augustus Voelcker.	*Alexander Cameron.*

Morgan, David James,

10, Northampton Place, Swansea.

Undergraduate of St. John's College, Cambridge. First Open

Natural Science Scholar (Chemistry and Physics), 1892, of St. John's College, Cambridge. Have worked in the laboratory of Dr. Wm. Morgan, Ph.D., F.C.S., F.I.C., for some time.

Otto Hehner. S. Ruhemann. W. Tirrill.
William Crookes. *William Ramsay.*

Peck, Herbert, L.R.C.P., L.R.C.S. Edinburgh, D.P.H. Cambridge,

Wigan Road, Ormskirk.

Medical Officer of Health. Possesses qualifications in Medicine, Surgery, and Public Health, and analyzes Water for the District Councils of Ormskirk and Sefton.

Wm. Jas. Orsman. W. Naylor. Edward Sergeant.
Alfred Hill. *E. Frankland.*

Pennington, William Henry,

Field House, Rochdale.

Manager. Head-Manager of the Dyeing and Bleaching and Silk Departments, John Bright and Bros., Limited, Fieldhouse Mills, Rochdale. Lecturer on Chemisty, Rochdale Co-operative Society's Science Classes, 1883–86. Formerly Student of Owens College and the Manchester Technical Schools. Passed 1st Class in applied Chemistry, Owens College, 1893.

Arthur G. Green. C. Rawson.
William Marshall. Thomas Stenhouse.
Robt. W. Oddy. Ernest Bentz.
R. Lloyd Whiteley. *Wm. A. Knight.*

Priest, Martin,

Apothecaries' Hall, Blackfriars,

Analyst. Three years under Professor Meldola, Finsbury Technical College, 1888–91. Assistant to W. A. Shenstone, Esq., F.I.C., Clifton College, 1891, May, 1893. Assistant to Wm. Chattaway, Esq., Public Analyst for Hammersmith and Borough of Colchester, May 1893—February, 1894, since which time I have held the appointment of Assistant Analyst to the Society of Apothecaries, London. I was associated with W. A. Shenstone, Esq., in a paper read before the Chemical Society, in May, 1893: "Studies on the formation of Ozone."

R. Meldola. W. A. Shenstone.
Frank. L. Teed. Edward Bevan.
C. G. Moor. Arthur B. Ling.
Julian T. Baker.

Ridge, W. T. B.,

2, Ashwood Terrace, Longton, Staffs.

Teacher, Higher Grade School, Hanley. As student: Studied inorganic and organic chemistry (practical and theory), together with other sciences for 9 years. Honoursman in Chemistry, &c., Science and Art Department. As teacher: Assistant Demonstrator in Chemistry at the Hanley Municipal Science Schools, 1893–94. Teacher in Science at the Stoke (1893–4–5) and Tunstall Science and Techniological Classes, and at the Higher Grade evening classes, Hanley, 1894–95.

James A. Audley. Wm. Hampton. R. Hornby.
G. G. Quinn. St. J. Gover.

Round, William,

45, St. Peter's Road, Handsworth, Birmingham.

Analytical Chemist. Seven years with A. E. Tucker, F.I.C., Analytical Chemist, 35, Paradise Street, Birmingham, four years of which time as chief assistant. 1st Class Honours Iron and Steel City and Guilds. 1st Honours Metallurgy Science and Art. 2nd Honours Practical ditto Science and Art. Seven years' training in Chemistry and Metallurgy and Metallurgical Chemistry.

Harry Silvester. Joseph Lones.
Arthur Adams. *Herbert McLeod.*
F. E. Matthews. *Thomas Turner.*

Rugginz, William Augustus,

114, Upton Lane, Forest Gate, E.

Lecturer and Demonstrator of Chemistry to the Worshipful Company of Carpenters' Technical Institute and Organized Science School, Stratford. Student of Finsbury Technical College, 1886–7–8. Appointed Special Lecturer in Chemistry, 1889–90, to London School Board.

R. Meldola. Thos. Tyrer. A. P. Laurie.
W. Palmer Wynne. Wm. Tate.

Seyler, Clarence Arthur,

31, Windsor Terrace, Swansea.

Analytical and Consulting Chemist. B.Sc. (Lond.) in Chemistry (Honours), Physics and Mathematics, F.I.C.; assistant successively to Dr. C. M. Tidy, to Mr. W. Crookes, F.R.S., and to Dr. W. Morgan, M.D., F.I.C. Interim Public Analyst for the County of Glamorgan and Borough of Swansea, &c. Author of series of articles on "Water Analyis," *Chem. News*, **70**, pp. 82, 104, 112, 140, 151, &c.

Otto Hehner. William Crookes. William Ramsay.
W. Terrill. *S. Ruhemann.*

Smith, Mathew, B.A.,

Aston Hall, Preston Brook, Cheshire.

Second Master, and Science Master at Aston Hall. Three years training in laboratory of W.F.K. Stock., F.C.S., F.I.C., County Analyst for Durham; three years training at Cambridge, in Chemistry, for Science Tripos under M. M. Patterson Muir, M.A., F.C.S., &c., and two terms teaching under Science and Art Rules at Knutsford Grammar School, and now Science Master at Aston Hall since September, 1894. Studied science also at Heidelberg, and at Edinburgh University, 1893.

W. F. Keating Stock. M. M. Pattison Muir.
A. Sheridan Lea. Alfred Hutchinson.
E. D. Walrond. A. Hutchinson.

Stephens, Frank R.,

(Idris and Co.), Camden Town.

Analytical Chemist. I have been under Dr. Muter for two sessions, also one course at the School of Pharmacy's Laboratory under Professor Attfield, and Chemical Lecture under Professor Dunstan. Since August, 1893, exclusively engaged in chemical work in the Laboratory of Messrs. Idris and Co. Special studies:—Bacteriology and Water Analysis. Passed the Major Examination, July, 1893.

W. H. Symons. M. Carteighe.
C. M. Luxmoore. T. A. W. Idris.
J. Hughes.

Stone, George,

Sydney, New South Wales.

Brewer. Chief brewer and chemist to J. T. & J. Toohey, Sydney, for the last 12 years; five years in conjunction with L. C. Daniell, F.C.S., for the same firm. Late Assistant to Messrs. Shanell and Sons, Birmingham. Appointed by the Jersey Milk Company, N.S.W., to analyse and report on the crystallisation of sugar and other changes occurring in and after the manufacture of condensed milk. Selected to analyse and report bacteriologically of ale imported to Australia. I urgently wish to avail myself of the reports and periodicals of the Society.

L. C. Daniell. Lawrence Briant. Gwilym Evans.
Wm. A. Dixon. *Henry H. Whitehead.*

Thorpe, Albert,

Charnwood House, Sleaford Road, Boston.

Analytical Chemist. Author of papers on "Monazite, a mineral containing Helium" (*Chem. News*, **72**, 32); "Recent Analyses of Leucite Basalt from Vesuvius" (*Chem. News*, **72**, 53); "A New Bacterial Pigment" (*Chem. News*, **72**, 82), &c. Silver Medallist in Chemistry and Physics.

A. B. Griffiths.	H. J. Mousley.
R. Savory Ladell.	W. Herbert Walden.
W. B. Bottomley.	*James Dewar.*
William Crookes.	*C. T. Kingzett.*

Tibbals, W. J.,

72, Lafayette Avenue, Detroit, Mich., U.S.A.

Chemist to the City of Detroit, Michigan, U.S.A. Graduate in Pharmacy, University of Michigan. Assistant for 15 months at the State Agricultural Experiment Station, Geneva, N.Y. Post Graduate Chemical Studies, University of Michigan, from 1891—1892. Assistant for 2½ years to Professor John A. Miller, Niagara University, Buffalo, N.Y.

John A. Miller.	Albert B. Prescott.
Charles Platt.	*Ernest A Congdon.*

Walter S. Haines.

Williams, John,

Wesley College, Sheffield, Schoolmaster.

Second Class Natural Science Tripos, Cambridge. Senior Science Master at Wesley College.

W. Carleton Williams.	Charles T. Heycock.
Douglas Berridge.	*Walter H. Joseland.*

Arthur Harden.

Wingfield, Thomas Rowland,

43, Dorset Street, Bolton.

Scientific Brewer. Studied chemistry for the last seven years, three of which were spent at the Manchester Technical School. During the above period the following examinations have been passed: Honours stage in brewing of the City Guilds; inorganic and organic theoretical chemistry, in practical inorganic chemistry, first class honours, South Kensington. In addition, I am a member of the Institutes of Brewing of London, and the North of England at Manchester, also of Society of Chemical Industry, Manchester Section.

William L. Hiepe.	Alex. K. Miller.
M. O. L. Whiteside.	Thomas Cockerill.
Jas. Grant.	*George H. Hurst.*

Wright, Harold E.,
Springhurst, Hartburn, Stockton-on-Tees, Metallurgical Chemist.

Head Assistant Chemist under Mr. C. H. Ridsdale, F.I.C., F.C S., &c., at the North Eastern Steel Works, Middlesborough, having occupied the position five years, entailing the conduct of the whole analytical work during that period, and Assistant for altogether over 11 years. First Class in Honours Grade, Iron and Steel Manufacturing, 1888 (City and Guilds). Have conducted investigations on the presence and estimation of arsenic in pig iron, steel, &c., the composition of various lubricants, &c. More recently, a series of experiments on the constitution and "citrate solubility" of basic slag in connection with a paper read by Mr. C. H. Ridsdale on the "Solubility of Basic Slag" (Cleveland Institute Engineers, January, 1895).

Edwd. Riley.	J. E. Stead.	H. Frankland.
C. H. Ridsdale.	A. C. Wilson.	E. H. Saniter.

Jno. Archyll Jones.

HARRISON AND SONS, PRINTERS IN ORDINARY TO HER MAJESTY, ST. MARTIN'S LANE.

Issued 3/12 1895

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

EDITED BY THE SECRETARIES.

No. 156. Session 1895–96.

November 21st, 1895. Mr. A. G. Vernon Harcourt, President, in the Chair.

Certificates were read for the first time in favour of Messrs. Joseph Edwin Alger Blyde, Nether House, Ranmoor, Sheffield; Arnold Eiloart, 2, Lansdowne Road, East Croydon; Walter Thomas Grice, 9, Dalhousie Square, Calcutta; James William Helps, 3, Tavistock Road, Croydon: Laurence W. Matthieson, 104. Grove Road, Bow, E.; Thomas Francis Rutter, The Huish School, Taunton; Arthur Philip Salt, Sunnyside, Pinner Road, Harrow; Amrita Lal Sircar, 51, Sankaritola. Calcutta; Benjamin Bernard Turner, 28. Lady Somerset Road, N.W.; and of Cass L. Kennicott, 4050, Ellis Ave., Chicago, Ill., U.S.A., approved by the Council under Bye-laws 1, 3.

The President announced that a letter of thanks had been received from the French Academy. for the address presented by the Society on the occasion of the centenary of the Academy, on October 25th.

Of the following papers those marked * were read:—

***135. "The influence of temperature on refractive power, and on the refraction equivalents of acetyl-acetone and of ortho- and paratoluidine." By W. H. Perkin, Ph.D., F.R.S.**

The author points out that whilst he has proved that the refraction equivalent of certain compounds is subject to variation at different temperatures, and Brühl has observed the same fact, his numbers, and those obtained by Brühl, are not in agreement. In the case of acetylacetone, the toluidines, and other compounds, it is observed that the two sets of determinations agree closely for ordinary atmospheric temperatures, but at higher temperatures Brühl's numbers show an increase, whilst the author obtains smaller numbers at higher temperatures. The author has satisfied himself that the apparatus used by him (Trans., 1892, 288), consisting of a hollow prism heated in an air-bath, furnishes uniform results, and by making observations with different specimens of material, he has proved that the differences between his numbers and Brühl's cannot be ascribed to impurity. Since the results for higher temperatures obtained by Nasini and Bernheimer, and by Kettler, using more or less independent methods, agree with the author's, he concludes that there must be some hitherto undiscovered error in the use of Brühl's refractometer at any temperature much above that of the atmosphere.

*136. "The evolution of carbon monoxide by alkaline pyrogallol solution during absorption of oxygen." By Frank Clowes, D.Sc.

It has long been known that under certain conditions carbon monoxide is evolved during the absorption of oxygen by alkaline pyrogallol. When a solution, 100 c.c. of which contains 10 grams of pyrogallol and 24 grams of potassium hydroxide, is used for the absorption of oxygen, it evolves no carbon monoxide until the percentage of oxygen in the gaseous mixture exceeds 28. The carbon monoxide evolved, however, increases in amount as the percentage of oxygen rises above that limit, until the carbon monoxide finally reaches about 6 per cent. of the volume of oxygen absorbed.

The process of estimation of oxygen is rendered perfectly accurate if the carbon monoxide which has been produced during the absorption is removed by means of cuprous chloride solution before the reading is taken.

Experiments with pyrogallol solution containing larger proportions of potassium hydroxide than that given above proved that the evolution of carbon monoxide may be entirely prevented under all conditions if the potassium hydroxide is present in sufficiently large proportion.

A solution, 100 c.c. of which contains 10 grams of pyrogallol and 120 grams of potassium hydrate, proved perfectly satisfactory in this respect; the weight of pyrogallol may be reduced to 5 grams in this solution.

A solution containing 18 per cent. of quinol (hydroquinone) and 24 per cent. of potassium hydroxide absorbed oxygen slowly, but the absorption was complete, and no carbon monoxide was evolved.

It is therefore evident that serious error may arise in estimating the proportion of oxygen present in a mixture containing only small proportions of other gases, unless the absorbent pyrogallol solution is prepared of suitable strength, or unless the absorption of oxygen is followed by the treatment of the residual gas with cuprous chloride solution.

*137. "The composition of the limiting explosive mixtures of various combustible gases with air." By Frank Clowes, D.Sc.

A series of experiments were made with mixtures in varying proportions of each combustible gas with air. A flame was brought into contact with each mixture, sometimes above and sometimes below, and it was noted whether the mixture burnt back independently of the external air. For each combustible gas there was thus obtained a lower percentage below which the mixture would not burn independently, and a higher percentage, above which the gas burnt independently only when it was supplied with more air.

The limiting percentages were as follows:—For methane, 5 and 13; for hydrogen, 5 and 72; for carbon monoxide, 13 and 75; for ethylene, 4 and 22; for water-gas, 9 and 55; for coal-gas, 5 and 28.

It was also proved that many mixtures which were outside but close to the above limits, and which could not be fired from above, could be fired from below.

Hence it is inferred:—

1. That the limiting explosive mixtures for different combustible gases vary widely.
2. That methane shows the narrowest limits, hydrogen the widest limits.
3. That the risks of a mixture being fired explosively increases with the different gases in the following order:—methane, ethylene, coal-gas, water-gas, carbon monoxide, hydrogen.
4. That the risk of explosion is greater when the mixture is kindled from below than when it is kindled from above.

DISCUSSION.

Mr. BENNETT H. BROUGH considered that it would have been a valuable addition to Professor Clowes' investigations if the action of other methods of firing had been tried. For it had to be remembered that colliery explosions were sometimes due to inflammation by sparks such as were produced by picks. Some interesting experiments had recently been made in the Moravian Ostrau coalfield in Austria with an apparatus for testing the liability of gaseous mixtures to inflammation in that way. A wheel was mounted on a vertical axis inside a casing, which was hermetically sealed and provided with a large removable cover. Definite proportions of gas were introduced and mixed with the air by revolving the wheel. An iron bar sliding through the casing was brought against the revolving wheel, and in case of an explosion the cover, which was secured by a chain, was blown off without further damage.

*138. "Note on the estimation of butyric acid." By W. H. Willcox, B.Sc.

In the estimation of butyric acid in the presence of acetic and formic acids, the acids were neutralised by a known excess of calcium carbonate. Hydrochloric acid was added in sufficient amount to neutralise the free calcium carbonate and to liberate the butyric acid from the calcium salt. The solution was distilled, and when the greater part had passed over, steam was passed through the liquid as long as the distillate continued acid. The distillate, which contained the butyric acid, was boiled with pure barium carbonate, the solution filtered, and evaporated to dryness.

It was found that when dried at 100° C., the salt did not attain a constant weight even after it had been heated for several weeks, diminutions of about 2 mg. (with 1 to 2 grams of salt) occurring after heat had been applied for three hours. This loss of weight did not occur at and below 80°.

Some barium butyrate was prepared, and was found to lose weight in a similar manner. At 90—100° C. losses of about 2 mg. occurred with three hours heating of 1·5 grams of salt, and even at 85° C. loss of weight occurred on continued heating. When the salt was kept at 80° C., however, it speedily arrived at a constant weight, which was not altered by continued heating.

These results show that in the estimation of mixtures of the volatile fatty acids, when butyric acid is present, the fraction of salts containing the butyrate must be dried at a temperature not exceeding 80° C.; if this temperature is exceeded, loss of weight occurs owing to the decomposition of the butyrate.

139. "Some derivatives of anthraquinone." By Edward Schunck, Ph.D., F.R.S., and Leon Marchlewski, Ph.D.

The authors have prepared the three hitherto unknown methylpurpuroxanthins. One of them was obtained by condensation of *o*-toluic acid with *m*-hydroxybenzoic acid. It crystallises in orange-coloured needles (m. p. 246°). Its diacetyl derivative is nearly colourless (m. p. 195°).

The other two methylpurpuroxanthins were obtained by condensation of *m*-toluic acid and *m*-hydroxybenzoic acid. The mixture of methylpurpuroxanthins produced, yielded two distinct compounds by fractional crystallisation from a mixture of alcohol and benzene. The constitution of these compounds was determined by studying the products of their oxidation. The more soluble one gave, on treatment with nitric acid, trimellitic acid, while the other one gave, on similar treatment, hemimellitic acid.

The authors point out that the constitutional formulæ proposed by them (Trans., 1894, 186) for the ethers of alizarin are supported by the work of Lagodzinski (*Ber.*, 1895, 1427), who obtained a monomethyl ether of alizarin by the condensation of hemipinic acid with benzoic acid.

The authors give a more precise account of the ethers of anthraquinoneoxime, mentioned by them in a preliminary paper previously published (*Ber.*, 1894, 2125). The methyl ether melts at 147°, the ethyl ether at 97°, and the benzyl ether at 82°.

140. "Efflorescence of Double Ferrous Aluminium Sulphate on Bricks exposed to Sulphur Dioxide." By David Paterson.

The author has analysed the efflorescence which appears on bricks composing chambers in which wool is bleached with sulphur dioxide. Four analyses were made, and the results agree well with the percentages required by the formula, $Al_2(SO_4)_3,FeSO_4,24H_2O$. The salt forms white fibrous crystalline masses resembling asbestos in appearance. It is evidently identical with the salt often found in volcanic regions, and the author's analyses agree well with those made by Forchammer of a specimen obtained from Iceland.

COLLECTIVE INDEX OF THE TRANSACTIONS, ABSTRACTS, AND PROCEEDINGS OF THE CHEMICAL SOCIETY.

Volume II, 1873 to 1882. Volume III, 1883 to 1892.

The Council, having determined to publish a Collective Index of their publications from 1873 to 1892 inclusive, will issue copies to Fellows who may notify their wish to receive them. Both volumes will be sent to those who were Fellows of the Society before the end of 1882. Volume III will be sent to Fellows who have joined the Society between 1st January, 1883 and 31st December, 1892. Fellows who are ineligible to receive copies *gratis*, and those who may have neglected to apply for them within the prescribed period, may obtain them by purchase at a price to be hereafter fixed. Fellows who desire the Index should notify their wish by letter, enclosing 1*s*. for cost of distribution, &c., to the Assistant-Secretary, Mr. Robert Steele, Chemical Society, Burlington House, W., before 31st December,

1895. For Fellows resident abroad, who should remit 2*s.*, which may be paid with their annual contribution, the time will be extended to 1st March, 1896.

A few copies of Vol. I (1841—72) can still be obtained, price 3*s.* post free.

RESEARCH FUND.

A meeting of the Research Fund Committee will be held in December. Applications for grants, accompanied by full particulars, should be sent to the Secretaries before December 11th.

At the next meeting on Thursday, December 5th, there will be a ballot for the election of Fellows, and the following papers will be read :—

"The constitution of terpenes." By Professor Armstrong, F.R.S.

"New derivatives from α-dibromo-camphor." Dr. M. O. Forster.

"On camphoic acid and its derivatives." By J. E. Marsh, M.A., and J. A. Gardner.

"The action of bromine on camphor." By Professor Armstrong, F.R.S.

"Isomeric π-bromo-α-nitrocamphors." By Drs. Lapworth and Kipping.

"π-Dibromocamphoric acid." By Dr. Kipping.

"Derivatives of α-hydrindone." By C. Revis and Dr. Kipping.

"Alkaline reduction of metanitraniline." By Professor Meldola, F.R.S., and E. R. Andrews.

"The chemistry of dibromopropylthiocarbimide and the action of bromine and iodine on allylthiourea." Professor A. E. Dixon.

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PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

EDITED BY THE SECRETARIES.

No. 157. Session 1895–96.

December 5th, 1895. Mr. A. G. Vernon Harcourt, President, in the Chair.

Certificates were read for the first time in favour of Messrs. John Allan, 242, Moss Lane East, Manchester; Herbert Lister Bowman, 13, Sheffield Gardens, Kensington, W.; James Kerry Burbridge, Moor's Lea, Winchmore Hill; Frank Dixon, 73, King Edward Road, South Hackney, N.E.; Joseph Edward Morrison, Montreal; Harold Rostron, 70, Davenport Street, Bolton; Peter B. Scotland, 30, Stirling Street, Airdrie, N.B.; Aitken Migget Simpson, 4, Kitto Road, St. Catherine's Park, S.E.; Henry G. Smith, Technological Museum, Sydney, N.S.W.

Mr. OTTO HEHNER called the attention of the Society to what he regarded as unprofessional conduct on the part of a Fellow of the Society whose name appeared on the certificates of certain candidates who were to be balloted for that evening.

Professor ARMSTRONG then moved, and Mr. GROVES seconded, that the Council be requested to consider this case. Professor TILDEN, having spoken in support of the motion, it was put to the meeting and carried.

The following were duly elected Fellows of the Society:—
George Percy Bailey, B.A., The Earl of Berkeley, Arthur Jenner Chapman, Wm. Chattaway, George Bertram Cockburn, B.A., Charles Crocker, Gurney Cuthbertson, William Dixon, Edward Henry Farr, Charles James Fauvel, Patrick Joseph D. Fielding, Jervis E. Foakes, Stanley Fox, James Gardner, Edward Graham, B.Sc.

Edward Henry Grossmann, The Rev. Henry Arthur Hall, M.A., Edgar Septimus Hanes, C. E. Harrison, B.A., James Henderson, B.Sc., Thomas Hawkins Percy Heriot, Frederick Arthur Hillard, B.A., Arthur Edward Holme, M.A., Oxon., Alfred James, Frederick Edward Johnson, William Oakes Kibble, Leonard P. Kinnicut, James McCreath, David James Morgan, William Henry Pennington, Martin Priest, W. T. B. Ridge, William Round, William Augustus Rugginz, Clarence Arthur Seyler, B.Sc., Mathew Smith, B.A., Frank R. Stephens, George Stone, W. J. Tibbals, John Williams, B.A., Thomas Rowland Wingfield, and Harold E. Wright.

Of the following papers those marked * were read:—

***141. "Researches on the terpenes. VI. Products of the oxidation of camphene: camphoic acid and its derivatives." By J. E. Marsh and J. A. Gardner.**

In this paper some of the oxidation products of camphene are described, among them being camphoic acid, $C_{10}H_{14}O_6$, as chief product, camphoric acid in small quantity, terephthalic acid, and succinic acid.

From camphoric acid were obtained:—Anhydrocamphoic acid, $C_{10}H_{14}O_5$; cis- and trans-camphopyric acids, $C_9H_{14}O_4$; camphopyric chloride, $C_9H_{12}Cl_2O_2$; Chlorocamphopyric chloride, $C_9H_{11}Cl_3O_2$; chlorocamphopyric anhydride, $C_9H_{11}ClO_3$; camphopyranilic acid, $C_9H_{13}O_3(NHC_6H_5)$; and salts of camphoic and camphopyric acids. With camphopyric acid is compared comphoric acid in respect of their both existing as cis- and trans-isomers, and also as regards the acid chloride, chloroacid chloride, and chloroanhydride, producible from both camphoric and camphopyric acids.

The reduction of camphopyric acid to hexahydrometaxylene has also been accomplished, while the constitution of camphene is discussed from the general analogy of camphoric and camphopyric acids, from the probability of their both containing a hexamethylene nucleus, from the fact of the production of both acids from camphene and from the probability that neither camphoic acid nor camphopyric acid is producible from camphoric acid.

Discussion.

Professor Armstrong inquired whether Mr. Marsh could give any further information as to the isomeric bromocamphor described by him on a previous occasion, since he (Professor Armstrong) had not been able to confirm Mr. Marsh's results.

If a molecular proportion of bromine be added to camphor heated on the water bath, using 1 or 2 per cent. in excess, so as to ensure the absence of camphor, an almost theoretical yield of bromocamphor (m. p. 76°) is obtained. If, to purify the product, it be dissolved in hot alcohol, the greater part of the bromocamphor at once crystallises out as the solution cools, and if the small amount of oily residue obtained from the mother liquor—a mixture of mono- and dibromo-camphor—be digested with alcoholic potash, so as to reduce the dibromo-compound, this also is converted into well-crystallised bromocamphor.

According to Marsh (Trans., 1890, 828), if camphor be brominated in presence of alcohol, almost half the product consists of an isomeric bromocamphor of ill-defined crystalline form and very low rotatory power. A product such as he describes can undoubtedly be obtained, but it is not difficult to separate bromocamphor from it, and its properties are certainly those of an impure material. It is desirable that this product should be more fully examined, and its nature definitely established, in view of the interest attaching to isomeric cis- and trans-modifications of camphor derivatives; the account given by Marsh is incomplete as it stands, and it is to be hoped that he will study further the action of bromine on camphor in presence of alcohol.

Mr. Marsh, in reply, said he had no doubt as to the existence of the second bromocamphor. He regarded the action of bromine on camphor as very considerably modified by the presence of alcohol, which, by reacting at once with the hydrobromic acid to form ethyl bromide, favoured the existence of the unstable isobromocamphor. The isobromocamphor has been obtained in crystals having a definite melting point. Its specific rotation is more than 100° lower than that of the ordinary modification, while it is also lower than that of camphor itself. When distilled it is converted partially, without appreciable decomposition, into the ordinary modification, the rotatory power after one distillation being raised about 50°, whilst ordinary bromocamphor may be readily obtained from the distilled product by crystallisation from alcohol.

*142 "New derivatives from α-dibromocamphor." By Martin O. Forster, Ph.D.

Early in this year a preliminary note was published in the Proceedings (p. 4), describing the behaviour of α-dibromocamphor towards nitric acid, an investigation undertaken at the suggestion of Professor Armstrong. It appears desirable to place on record the results which have since been obtained in this connection.

It has been already stated (*loc. cit.*) that a compound of the formula $C_{10}H_{12}Br_2O_2$ is produced when α-dibromocamphor is acted on by fuming nitric acid (*d.* 1·52), and that reduction with zinc dust and alcoholic ammonia converts this substance into a compound of the formula $C_{10}H_{13}BrO_2$. A fuller investigation has shown that the composition of these products is represented by the formulæ $C_{10}H_{14}Br_2O_2$ and $C_{10}H_{15}BrO_2$ respectively, which, in fact, correspond more closely to the analytical results already published than do the formulæ previously chosen.

The compounds $C_{10}H_{14}Br_2O_2$ and $C_{10}H_{15}BrO_2$ having given rise to numerous derivatives, it has been found necessary to adopt some system of nomenclature by means of which they may be designated and the scheme which is now proposed has been selected because it aims at representing in the name of a derivative the class of compounds to which it belongs. It having been found that the initial compound $C_{10}H_{14}Br_2O_2$ has the properties of a lactone, this substance will be referred to as *dibromocampholid;* the product of its reduction, $C_{10}H_{15}BrO_2$, is an unsaturated (carboxylic) acid, and will be called *bromocamphorenic acid*, the termination "olid" being significant of lactones, whilst ethylenic linking is represented by the syllable "en."

Dibromocampholid, $C_{10}H_{14}Br_2O_2$, is obtained by the action of fuming nitric acid (*d.* 1·52) on α-dibromocamphor in quantity amounting to about 10 per cent. of the material used; it crystallises in long, colourless, transparent needles, and melts at 152°. Alcoholic potash converts it into the *lactone*, $C_{10}H_{14}O_3$, which melts at 174°, and yields the *acid* $C_{10}H_{16}O_4$ on hydrolysis; the lactone is readily converted by bromine into the *bromolactone*, $C_{10}H_{13}BrO_3$, which crystallises from alcohol in lustrous, silky needles, and melts at 196—197°.

Bromocamphorenic acid, $C_{10}H_{15}BrO_2$, is formed when an alcoholic solution of dibromocampholid is reduced with zinc dust and ammonia; it crystallises from alcohol in thin, lustrous, six-sided plates, and melts at 159°. The *barium* salt contains $2H_2O$, and the *zinc*, *copper*, and *silver* salts are also crystalline; the *methylic* salt is a fragrant oil, which boils at 255° under a pressure of 767·5 mm. The unsaturated character of bromocamphorenic acid is indicated by its behaviour towards potassium permanganate, which is immediately decolorised by the solution in sodium carbonate, a dicarboxylic *acid* being produced having the formula $C_{10}H_{16}O_6$, and melting at 184°; a cold solution of bromine in chloroform is at once decolorised by the acid in the same medium, hydrogen bromide and dibromocampholid being formed.

Camphorenic acid, $C_{10}H_{16}O_2$, is obtained by reducing a boiling alkaline solution of bromocamphorenic acid with sodium amalgam; it crystallises from alcohol in colourless needles, and melts at 161°. The *sodium* salt crystallises from strongly alkaline solutions in silky needles; the *methylic* salt is a colourless oil, which boils at 215° under a pressure of 767·5 mm., and has the odour of camphor. The *anhydride*, $C_{20}H_{30}O_3$, melts at 84—85°.

α-Bromocampholid, $C_{10}H_{15}BrO_2$, is obtained by the action of concentrated sulphuric acid on bromocamphorenic acid, and is isomeric with that substance; the production of an isomeric lactone under the influence of sulphuric acid, and the formation of a bromolactone on treatment with bromine, are features which characterise βγ-unsaturated acids. α-Bromocampholid crystallises from alcohol in lustrous plates, and melts at 92—93°; it is indifferent towards bromine, and is hydrolysed by a boiling aqueous solution of barium hydroxide.

β-Bromocampholid is isomeric with the foregoing substance, and is formed from camphorenic acid or the sodium salt and bromine; it crystallises from ether in transparent prisms, and melts at 62°. It is indifferent towards bromine, and when the alcoholic solution is reduced with zinc dust and ammonia, camphorenic acid is formed.

Campholid, $C_{10}H_{16}O_2$, is obtained by dissolving camphorenic acid in concentrated sulphuric acid, the change being parallel with that attending the conversion of bromocamphorenic acid into α-bromocampholid; it is very readily soluble in most organic solvents, but separates from petroleum in minute white crystals, and melts at 176—177°. Campholid is very volatile, and sublimes slowly below 100°; it resembles camphor in appearance, and has the odour of that substance. It is indifferent towards bromine, but yields an acid, $C_{10}H_{18}O_3$, on hydrolysis, which crystallises from ethylic acetate in magnificent lustrous needles, melting at 179°.

*143. "Isomeric π-bromo-α-nitro camphors." By Arthur Lapworth, D.Sc., and F. Stanley Kipping, Ph.D., D.Sc.

It has already been shown by one of the authors (Proc., 148, 39), that π-dibromo-camphor is attacked by concentrated nitric acid, and that the product consists partly of a bromocamphoric acid and partly of an oil, which, by the action of alcoholic potash, yields a bromonitro-camphor.

It has now been found that if this oil be boiled with concentrated nitric acid until it is free from π-dibromo-camphor, it subsequently solidifies to a crystalline cake, from which *bromonitro-camphor* can be easily isolated. (Found C = 34·05; H = 4·21; Br = 44·98 per cent. Calc. C = 33·80; H = 3·67; Br = 45·05 per cent.).

This compound separates from cold light petroleum in the form of long, flat needles, melting at 54°, and is insoluble in water, but soluble in most of the usual organic solvents. When boiled with alcoholic potash it loses 1 atom of bromine, and affords the potassium salt of the bromo-nitro-camphor previously described (*loc. cit.*). The further investigation of this bromo-nitro-camphor leads to the conclusion that it is polymorphous. The crystals from chloroform and petroleum melt sharply at 133—134°, and solidify on cooling to a crystalline mass, which fuses at 126°; this is also the melting point of crystals obtained from alcoholic or dilute acetic acid solutions, whereas large pyramidal crystals deposited from a mixture of ethylic acetate and chloroform melt at 108° immediately solidify, and melt once more at 126°. A 6 per cent. solution gave $[\alpha]_D = +33·04$.

Reduction of π-bromo-α-nitro-camphor with zinc dust and acetic yields an amido-compound with a strong ammoniacal odour, which is probably ordinary amido-camphor, as it contains no bromine, and agrees in properties with the compound described by Schiff (*Ber.*, **13**, 1404).

If, however, the bromo-nitro-camphor be carefully reduced with sodium amalgam in alkaline solution, it is converted into a new π-bromo-α-amido-camphor, $C_{10}H_{14}BrONH_2$, the hydrochloride of which crystallises from water or acetone in colourless needles or plates. (Calculated for $C_{10}H_{14}BrONH_2·HCl$. C = 42·46; H = 6·03; Br + Cl = 40·81. Cl = 12·56. Found C = 42·57; H = 6·05: Br + Cl = 40·36. Cl = 12·70).

The oxalate is almost insoluble in water, and melts at 201°; the platinichloride forms silky, yellow needles, melting with decomposition about 219°.

π-Bromo-α-nitro-camphor dissolves in hot hydrochloric acid, and the solution on cooling deposits crystals of a new compound, which is soluble in hot sodium carbonate solution, and separates from benzene in flat needles melting at 137°. This substance is an isomeric π-bromo-α-nitro-camphor. (Found C = 43·57; H = 5·32. Calc. C = 43·47; H = 5·07 per cent.).

It differs from its isomeride inasmuch as it dissolves readily in hot water, crystallising from the solution in thin plates melting at 108°; it is also much less soluble in ethylic acetate and in benzene, and it yields a blue copper salt, that of its isomer being pink. Its specific rotation is also much greater, viz., $[\alpha]_D = +52·7$.

That these two π-bromo-α-nitro-camphor are structurally identical is probable from the fact that they both yield π-bromo-camphoric acid on oxidation with nitric acid; it is concluded, therefore, that the difference between these two substances is of the same nature as that subsisting between cis- and trans-modifications of cycloïd derivatives.

*144. "Derivatives of π-bromocamphoric acid." By F. Stanley Kipping, Ph.D., D.Sc.

π-Bromocamphoric acid, $C_{10}H_{15}BrO_4$, prepared by oxidising π-dibromo-camphor (Proc., 148, 33), is readily acted on by alkalis giving, according to the conditions of the experiment, a lactonic acid, $C_{10}H_{14}O_4$ (m. p. 164—165°), or π-hydroxycamphoric acid, $C_{10}H_{16}O_5$ (Proc., 151, 88).

The lactonic acid is the initial, and not the final, product of the action, as was at first supposed; when heated with excess of aqueous potash it is converted into a salt of the π-hydroxy acid. The hydroxy-acid, treated with acetic chloride, yields an acetyl derivative of its anhydride; this substance crystallises from ethereal petroleum in prisms melting at 89—90°, and is dimorphous, another modification melting at 86—87°. When the hydroxy-acid is distilled, it yields as principal product a lactonic acid, $C_{10}H_{14}O_4$ (m. p. about 226°), isomeric with the compound referred to above, and identical with that obtained by heating π-bromo-camphoric acid with quinoline (*loc. cit.*). The lactonic acid of lower melting point is also converted on distillation into the isomeride of higher melting point, whereas the latter, on fusion with potash, gives the π-hydroxy-acid.

π-Hydroxycamphoric acid and the lactonic acid melting at 164—165°, are readily oxidised by nitric acid, giving an acid of the composition $C_{10}H_{14}O_6$ (*loc. cit.*), but the lactonic acid of higher melting point is exceedingly stable, and seems not to be attacked by boiling nitric acid; on prolonged treatment with alkaline permanganate, however, either at ordinary temperatures or at 100°, it yields, amongst other products not yet investigated, a small quantity of a derivative of dihydroxycamphoric acid, $C_{10}H_{16}O_6$, namely, a hydroxylactonecarboxylic acid of the composition $C_{10}H_{14}O_5$. This substance crystallises from hot water, in which it is readily soluble, in long, slender needles, and from a mixture of moist ether and ethylic acetate in well-defined, transparent prisms melting at about 265°; these crystals lose $1H_2O$, and become opaque when heated at 100°, so that the substance is probably a monohydroxylactonic acid of the composition $C_{10}H_{14}O_5 + H_2O$, and not a dihydroxy compound. Its identity with the acid obtained from π-dibromocamphoric anhydride (see following note), and the fact that the lactone ring in the substance (m. p. 226°) from which it is derived is very stable, lead to the conclusion that it is the π-hydroxy group which has taken part in the lactone formation.

It seems probable from the facts already established that the π-bromine atom in π-bromo-camphoric acid is a constituent of a $-CH_2Br$ group.

145. "π-Dibromocamphoric acid and its derivatives." By F. Stanley Kipping, Ph.D., D.Sc.

The derivatives of π-bromocamphoric acid, which have been referred to in the preceding and in previous notes, are so stable that attempts to obtain from them simple oxidation products containing less than 10 atoms of carbon have so far been unsuccessful; as they also resist the action of bromine, or give with it ill-defined substances, experiments were made with the object of brominating π-bromocamphoric acid itself, in the hope of obtaining a dibromo-derivative which, on treatment with alkalis, would yield products more easily oxidisable than those prepared from the monobromo-acid.

π-Dibromocamphoric anhydride, $C_{10}H_{12}Br_2O_3$, is obtained on treating dry π-bromocamphoric acid with bromine and amorphous phosphorus under the usual conditions; it crystallises from chloroform in large, transparent plates, melts at about 210° without decomposing, and is readily soluble in warm chloroform but very sparingly in cold ether, and insoluble in cold water and cold sodium carbonate solution.

π-Dibromocamphoric acid, $C_{10}H_{14}Br_2O_4$, is deposited in small plates when the anhydride is dissolved in hot concentrated nitric acid and the solution evaporated on the water bath; it melts and decomposes at 210—211°, and is readily soluble in cold ether, but insoluble, or nearly so, both in chloroform and in hot water. It dissolves in dilute sodium carbonate solution with effervescence, and on acidifying the solution after heating for a few minutes π-bromocamphanic acid (see below) is precipitated. π-Dibromocamphoric acid is stable at 100°, but when heated at its melting point part is reconverted into the dibromo-anhydride and part is transformed into π-bromocamphanic acid with liberation of hydrogen bromide.

π-Bromocamphanic acid, $C_{10}H_{13}BrO_4$, is formed when the dibromo-anhydride is boiled for some hours with water and a little alcohol; it separates from cold dilute alcohol in fern-like crystals which contain water, but from hot water and from a mixture of chloroform and ethyl acetate anhydrous crystals are deposited; it melts at 176—177°, and is soluble in sodium carbonate solution with effervescence.

On prolonged boiling with water, or on heating with aqueous alkalis, π-dibromocamphoric acid is converted into an acid melting at about 265°, and identical with the oxidation product described in the preceding note.

146. "*w*-Bromocamphoric acid." By F. Stanley Kipping, Ph.D., D.Sc.

The fact that π-bromocamphoric acid is obtained directly on oxidising π-dibromocamphor, whereas the π-dibromocamphoric acid can be prepared from the corresponding anhydride (see preceding abstract) led the author to try and isolate the unknown bromocamphoric acid corresponding with Wreden's bromocamphoric anhydride: this was accomplished by hydrolysing the anhydride with concentrated nitric acid under suitable conditions, but the yield was comparatively small, most of the anhydride being recovered.

The bromocamphoric acid, which, it is proposed, should be distinguished from the isomeric π-acid by using the initial letter of Wreden's name (he having first prepared the anhydride), crystallises from a mixture of chloroform and ether in large, transparent, orthorhombic pyramids, having the composition $C_{10}H_{15}BrO_4$. (Found $C = 42·9$, $H = 5·4$: theory $C = 43·0$, $H = 5·4$ per cent.) It dissolves freely in ether, but is almost insoluble in benzene and chloroform, and melts at 195—196°, charring slightly and effervescing: it is readily soluble in sodium carbonate solution, by which it is rapidly decomposed, yielding ordinary camphanic acid. When heated for a short time with acetic chloride the acid is reconverted into the anhydride from which it is derived.

Aschan (*Ber.*, **27**, 2112, and **28**; Ref. 922), has recently isolated an acid, which he designates *l*-bromisecamphoric acid; this compound appears to be different from the acid which forms the subject of the present communication, but Aschan's original paper being at present inaccessible, this point cannot be finally settled.

The author also refers to a curious phenomenon observed in crystallising *w*-bromocamphoric anhydride from chloroform; in some cases the solution becomes highly supersaturated, and crystallisation ultimately takes place with almost explosive violence.

147. "π-Chlorocamphoric acid." By F. Stanley Kipping, Ph.D., D.Sc., and William J. Pope.

Optically inactive camphor sulphonic chloride (Kipping and Pope, Trans., 1893, **63**, 548) yields, on distillation, two products, namely, a crystalline inactive π-chlorocamphor and an oil (Trans., 1895, **67**, 371).

When the mixture of these two compounds is heated with nitric acid the oil is rapidly oxidised and passes into solution, but π-chlorocamphor, like π-dibromocamphor is attacked and dissolved rather slowly.

On cooling the solution, crystals and an oil are deposited. The crystalline substance is π-chlorocamphoric acid, the oil being probably π-chloro-α-nitrocamphor, the formation of which, under the above condition, would be analogous to that of πα-dibromo-α-nitrocamphor from πα-dibromocamphor (see preceding note by Lapworth and Kipping); other substances are present in the filtrate from nitric acid, but they have not yet been examined.

Inactive π-chlorocamphoric acid, $C_{10}H_{15}ClO_4$ resembles π-bromocamphoric acid very closely in ordinary properties. It is very sparingly soluble in hot water, from which it crystallises in small, lustrous prisms melting at about 195°. It is almost insoluble in chloroform, but dissolves freely in ether, methyl alcohol, and acetone.

This chloro-acid is doubless structurally similar to π-bromocamphoric acid, but whereas the latter is a derivative of an optically active π-bromocamphor, the chloro-acid is derived from an inactive or racemic halogen derivative of camphor.

A chlorocamphoric anhydride has been recently described by Aschan (*Ber.*, 28, Ref., 922), but this substance is derived from an acid structurally as well as optically different from π-chlorocamphoric acid.

148. "Derivatives of α-hydrindone." By C. Revis and F. Stanley Kipping, Ph.D., D.Sc.

The study of α-hydrindone (Trans., 1894, 480) has been continued, and attempts have been made to convert it into $\alpha\beta$-diketohydrindone; up to the present, however, this substance has not been obtained.

Two compounds are formed on treating α-hydrindone with a solution of bromine in soda according to the conditions of the experiment; if the ketone be simply shaken with the alkaline solution at ordinary temperatures, it is slowly converted into a bulky mass consisting of ordinary dibromohydrindone (m. p. 132°), whereas if the mixture be heated on the water bath, a heavy crystalline powder is formed, apparently by further action on the dribrom-compound. The latter is very sparingly soluble in most ordinary solvents, but may be crystallised from boiling acetic acid, from which it separates in long, colourless needles decomposing between 250° and 260°. Analyses show it to be a condensation product of the composition $C_{18}H_{12}O_3$, but its constitution has not yet been established.

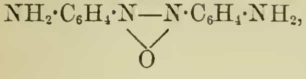
When monobromohydrindone is dissolved in alcoholic potash at ordinary temperatures it furnishes a substance which crystallises from chloroform in large, transparent, well-defined prisms. This compound is a condensation product of the composition $C_{18}H_{13}BrO_2$.

Dibromohydrindone (m. p., 132°) is readily acted on by alcoholic potash yielding various products according to the conditions of the experiment.

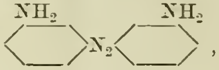
If the potash be added gradually until the solution becomes permanently alkaline, the dibromo-derivative is converted into a new substance which crystallises from benzene in lustrous needles of indefinite melting point (decomposing from 150—160°).

149. "The alkaline reduction of metanitraniline." By Raphael Meldola and Ernest R. Andrews.

On heating an aqueous solution of metanitraniline with alkaline reducing agents, such as sodium stannite, the azoxy-compound,



$NH_2{\cdot}C_6H_4{\cdot}\underset{\diagdown\,O\,\diagup}{N{-}N}{\cdot}C_6H_4{\cdot}NH_2$, separates out on cooling. It forms yellow scales (from toluene) or needles (from boiling water or dilute alcohol); m. p. 146—148°. The diacetyl-derivative (m. p. 254)°, the disazimide (m. p. 86—85°), the disazo-β-naphthol derivative (m. p. 244—245°), and the metadiiodoazoxybenzene (m. p. 118—119°) have been prepared from the diamidoazoxy-compound. The corresponding azo-compound, having the constitution—



has been prepared by the complete reduction of the azoxy-compound to a hydrazo-compound by the action of zinc dust and alkali, and subsequent reoxidation. This has been found the most effective way of obtaining the azo-compound in a state of purity. It consists of dull orange needles when crystallised from boiling water; m. p. 150—151°. The diacetyl-derivative (m. p. 272°), the dibenzoyl-derivative (m. p. 284—285), the disazo-β-naphthol (m. p. 282°), and the oxalate of the base have been prepared, and are described in the paper. The constitution was confirmed by conversion into the meta-diiodoazobenzene (m. p. 150—151°) of Gabriel (*Ber.*, 1876, **9**, 1410). Both the azoxy- and azo-compounds are well characterised bases forming diacid salts. The paper concludes with a theoretical discussion by one of the authors (Meldola) of the process of reduction of nitro-compounds.

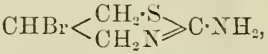
150. "The chemistry of dibromopropylthiocarbimide; and the action of bromine and iodine upon allylthiourea." By Augustus E. Dixon, M.D.

Having failed to obtain dibromopropylthiourea from $\beta\gamma$-dibromopropylthiocarbimide and ammonia (Trans., 1892, **61**, 548), the author proceeded to re-examine a compound obtained by Maly (*Zeits. f. Chem.*, 1867, 42) from allythiourea and bromine. This compound, "thiosinnamine dibromide," $C_4H_8N_2SBr_2$, is, however, not dibromopropylthiourea, but proves to be the hydrobromide of a well-marked base, $C_4H_7N_2SBr$, which is precipitated, on the addition of caustic alkali, as a dense, almost colourless, strongly alkaline oil. The oil is sparingly soluble in water; it combines with hydrochloric acid to form the hydrochloride, $C_4H_7N_2SBr,HCl$, hard white prisms melting at 129—130°, and identical with the "bromochloride" obtained by Maly from "thiosinnamine dibromide" and moist AgCl. The hydrobromide, $C_4H_7N_2SBr,HBr$, from the base and HBr, is identical with the dibromide; it was found to melt at 139—140°. By treatment of either the free base or its hydrobromide with picric acid, the salt $C_4H_7N_2SBr,C_6H_2(NO_2)_3OH$ is precipitated; when recrystallised from dilute spirit it forms minute, glittering prisms, pale yellow in colour, and melting at 187—188°.

Heat is evolved on mixing dibromopropylthiocarbimide with alcoholic ammonia; ammonium bromide separates, and is left, together with a brownish syrup, when the alcohol is evaporated; this syrup is the brominated base $C_4H_7N_2SBr$, somewhat impure.

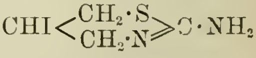
$$CH_2Br\cdot CHBr\cdot CH_2\cdot NCS + 2NH_3 = NH_4Br + C_4H_7N_2SBr.$$

Reasoning from the conditions under which the base is produced, from its alkaline character, and from the fact that it is not desulphurised by treatment with alkaline lead, or ammoniacal silver solutions, the author regards it as having the probable constitution

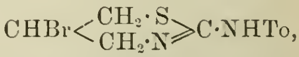


$$\mathrm{CHBr}\!<\!\begin{matrix}\mathrm{CH_2\cdot S}\\ \mathrm{CH_2\cdot N}\end{matrix}\!\geqslant\!\mathrm{C\cdot NH_2},$$

i.e., μ-amido-γ-brompenthiazoline, otherwise β-bromotrimethylene-$\psi\mu$-thiourea. This view also receives support from the results of experiments by Gabriel and others, on the interaction of brominated fatty bases with thiocarbimides, whereby the tendency has been shown of monohalogenised fatty thioureas to lose, at the moment of formation, their contained halogen, with production of the corresponding haloïd salts of closed-chain bases of the above type.

Iodine appears not to combine with allylthiocarbamide, but acts similarly to bromine on allylthiourea, giving the hydriodide of an iodised base, $C_4H_7N_2SI,HI$. The salt is freely soluble in water or spirit, and melts at 132·5—133·5. When treated with caustic potash the base is thrown down as a dense, sticky oil, alkaline to litmus, nearly insoluble in water, reacting (like its brominated analogue) for halogen with chlorine water, and yielding a picrate of m. p., 176—177°. The constitution assigned to it is  $\mathrm{CHI}\!<\!\begin{matrix}\mathrm{CH_2\cdot S}\\ \mathrm{CH_2\cdot N}\end{matrix}\!\geqslant\!\mathrm{C\cdot NH_2}$ = μ-amido-γ-iodpenthiazoline.

Similar compounds were obtained by acting with organic bases upon dibromopropylthiocarbimide.

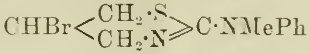
μ-Orthotolylamido-γ-brompenthiazoline,  $\mathrm{CHBr}\!<\!\begin{matrix}\mathrm{CH_2\cdot S}\\ \mathrm{CH_2\cdot N}\end{matrix}\!\geqslant\!\mathrm{C\cdot NHTo}$, from the thiocarbimide and *o*-toluidine, was deposited from alcohol in rhombic plates, m. p. 134·5—135·5°. It is insoluble in water, rather difficultly soluble in alcohol, feebly alkaline to litmus, and—like the other compounds of its class—retains its sulphur, even when boiled with alkaline lead, or ammoniacal silver salts. The hydrobromide is a clear, pale brown, apparently uncrystallisable, acid syrup.

μ-Paratolylamido-γ-brompenthiazoline hydrobromide formed a thick,

acid syrup; the free base occurred in rosettes of pointed white prisms melting at 124—125°.

μα-Naphthylamido-γ-brompenthiazoline, like its hydrobromide, could only be obtained as a liquid. The hydrobromide of the corresponding *β-naphthyl-compound* was a brownish, tenacious acid syrup; its base occurred in brilliant prisms, neutral at litmus, and melting at 190—191°.

μ-Methylphenylamido-γ-brompenthiazoline,

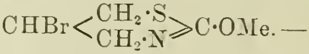


$$CHBr<\begin{matrix}CH_2\cdot S\\ CH_2\cdot N\end{matrix}\geqslant C\cdot NMePh$$

(from the thiocarbimide and methylaniline, with evolution of heat), separated as a colourless oil; its hydrobromide is crystalline, easily soluble in hot water, and melts at 183—184°.

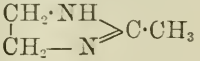
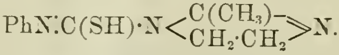
μ-Piperidyl-γ-brompenthiazoline, $CHBr<\begin{matrix}CH_2\cdot S\\ CH_2\cdot N\end{matrix}\geqslant C\cdot NC_5H_{10}$.—Produced with evolution of heat; the HBr salt forms colourless, vitreous prisms, soluble in cold water, with neutral reaction; m. p., 189—190°. The base is a nearly colourless syrup, which does not afford bromine when mixed with chlorine water; it is so strongly alkaline as to allow of titration by standard acid.

By acting with methylic, ethylic, and propylic alcohols respectively at a little over 100° on the thiocarbimide, the three following compounds were obtained, together with (free) hydrogen bromide.

μ-Methoxy-γ-brompenthiazoline,  $CHBr<\begin{matrix}CH_2\cdot S\\ CH_2\cdot N\end{matrix}\geqslant C\cdot OMe$.—White crystals easily soluble in hot water: not desulphurised by silver or lead salts; m. p. 95—96°. The silver compound becomes purple on short exposure to actinic light.

μ-Ethoxy-γ-brompenthiazoline.—Small, white prisms, moderately soluble in hot water; m. p. 96—97°. Forms a silver compound which is very markedly light-sensitive.

μ-Propoxy-γ-brompenthiazoline.—Pyramidal crystals: m. p., 96—97°; closely resembling the preceding compound in properties.

Phenyl and orthotolylthiocarbimides respectively combine, evolving heat, with *μ*-methylimidazoline,  $\begin{matrix}CH_2\cdot NH\\ |\\ CH_2—N\end{matrix}\geqslant C\cdot CH_3$ (ethenylethylene diamine), thereby affording  $PhN{:}C(SH)\cdot N<\begin{matrix}C(CH_3)—\\ CH_2\cdot CH_2\end{matrix}\geqslant N$.

μ-Methylimidazolylphenylthiourea.—Thick, lustrous prisms, difficultly soluble in cold water or alcohol; desulphurised by lead and silver salts; m. p., 173—174°.

*μ-Methylimidazolyl-*o*-tolylthiourea.*—White crystals melting at 159—159·5°, and generally resembling the corresponding phenyl-derivatives.

ADDITIONS TO THE LIBRARY.

I. *Pamphlets.*

On the Colour Reactions of Atoms, Ions, and Molecules. By M. Carey Lea. Part I with Plate.

The causes and nature of Fermentative Changes in Natural and Polluted Waters, and in Artificial Solutions, as indicated by the Composition of the Dissolved Gases (Parts I, II, and III). By W. E. Adeney, Assoc. R.C.Sc.I., F.I.C. Pp. 539—620. 4to. Dublin 1895. From the Author.

On the Multiple Proportions of the Atomic Weights of Elementary Substances in relation to the Unit of Hydrogen. By Henry Wilde, F.R.S.

On the Evidence afforded by Bode's Law of a Permanent Contraction of the *Radii Vectores* of the Planetary Orbits. By Henry Wilde, F.R.S.

Ricerche sull' Essenza di Bergamotto e sulle sue Sofisticazioni del dott Ignazio Campolo.

The Volcanic Rock of Alum Hill, Boulder County, Colorado. By C. I. Andrews.

The recent History and present Status of Chemistry. By Professor Charles S. Palmer.

Vein Structure in the Enterprise Mine. By T. A. Rickard.

Notes on the Precipitation of the Precious Metals from Cyanide Solutions by means of Zinc. No. I. The Non-existence of Cyanide of Zinc in Alkaline Solutions. By Nicholai Anderson, Denver.

The Determination of Bismuth in Refined Lead and in Lead Bullion. By L. G. Eakins.

The Contributions of Chemistry to the Methods of Preventing and Extinguishing Conflagration. By Thos. H. Norton.

Michigan Mining School, Houghton, Michigan. Prospectus of Elective Studies. May, 1895.

A Contribution to the Chemistry of Australian Myrtaceous Kinos. By J. H. Maiden, F.L.S., and H. G. Smith. June, 1895.

Estudios Ijieniqos del Aire. Por A. E. Salazor I. Q. Newman. Santiago 1895.

The Philosophy of Substantialism, or Matter, Force, and Energy. By Henry A. Mott, Ph.D., LL.D.

The Oximes of Benzaldehyde and their Derivatives. By C. M. Luxmoore, B.Sc. A Thesis accepted for the Degree of D.Sc. of the University of London.

Analysis of Commercial Fertilisers. By F. B. Guthrie Department of Agriculture. Sydney, N.S.W., 1895.

Notes on the Milling Qualities of Different Varieties of Wheat.

By F. B. Guthrie and E. H. Gurney. Department of Agriculture. Sydney, N.S.W., 1895.

On the Choice and Use of Artificial Manures. By F. B. Guthrie, F.C.S. Department of Agriculture. Sydney, N.S.W., 1894.

Australian Honey. By F. B. Guthrie. Department of Agriculture. Sydney, N.S.W., 1894.

Analysis of Tumut Tobacco. By F. B. Guthrie. Department of Agriculture. Sydney, N.S.W., 1894.

Ostwald, Dr. Wilhelm. Die Überwindung des Wissenschaftlichen Materialismus Pp. 36. Leipzig 1895.

Meyer, Dr. Victor. Probleme der Atomistik. Zweite Auflage. Pp. 45. Heidelberg 1896.

Meyer, Dr. Victor. Chemische Probleme der Gegenwart. Zweite Auflage. Pp. 46. Heidelberg 1890.

II. *By Purchase.*

Ostwald, Dr. Wilhelm. Elektrochemie; ihre Geschichte und Lehre. Mit 260 Nachbildungen geschichtlicher Originalfiguren. Pp. xvi + 1151. 8vo. Leipzig 1896.

Neumeister, Richard. Lehrbuch der physiologischen Chemie: mit Berücksichtigung der pathologischen Verhaltnisse: für Studierende und Aerzte. Zweiter Teil. Die tierischen Gewebe und Flüssigkeiten. Pp. x + 420. Jena 1895.

Jahn, Hans. Grundriss der Elektrochemie. Pp. x + 311. Wien 1895.

Nernst, W., und Schönflies, A. Einführung in die mathematische Behandlung der Naturwissenschaften. Kurzgefasstes Lehrbuch der Differential- und Integralrechung mit besonderer Berücksichtigung der Chemie mit 61 im Text befindlichen Figuren. Pp. xi + 309. München and Leipzig 1895.

Hammarsten, Olof. Lehrbuch der physiologischen Chemie. Dritte völlig umgearbeitete Auflage. Pp. x + 647. Weisbaden 1895.

Tiemann, Dr., Walter, G., und Gärtner, Dr. A. Tiemann Gärtner's Handbuch der Untersuchung and Beurtheilung der Wasser zum Gebrauch für Apotheker, Ärzte, Chemiker, fabrikanten Medicinalbeamte und Techniker. Vierte vollständig umgearbeitete und vermehrte Auflage. Pp. xxxvi + 841. Braunschweig 1895.

Schoop, Paul. Die Sekundär-Elemente: auf Grundlage der Erfahrung dargestellt. I. Teil. Die Theorie des Blei-Sammlers und Construktion von Planté-Batterien. Pp. viii + 210. II. Teil. Die Fabrikation von Blei-Sammlern. Pp. vii + 211. Halle. 1895.

Le Blanc, Max. Lehrbuch der Elektrochemie: mit 32 Figuren. Pp. viii + 226. Leipzig 1896.

Dragendorff, Georg. Die gerichtlich-chemische Ermittelung von Giften in Nahrungsmitteln, Luftgemischen, Speiseresten, Korpertheilen, etc. Vierte, völlig umgearbeitete Auflage. Pp. xiv+532 Göttingen 1895.

HELMHOLTZ MEMORIAL LECTURE.

The Helmholtz Memorial Lecture will be delivered by Professor G. F. Fitzgerald, F.R.S., at an extra meeting of the Society to be held on Thursday, January 23, 1896, at 8 P.M.

COLLECTIVE INDEX OF THE TRANSACTIONS, ABSTRACTS, AND PROCEEDINGS OF THE CHEMICAL SOCIETY.

Volume II, 1873 to 1882. Volume III, 1883 to 1892.

The Council, having determined to publish a Collective Index of their publications from 1873 to 1892 inclusive, will issue copies to Fellows who may notify their wish to receive them. Both volumes will be sent to those who were Fellows of the Society before the end of 1882. Volume III will be sent to Fellows who have joined the Society between 1st January, 1883, and 31st December, 1892. Fellows who are ineligible to receive copies *gratis*, and those who may have neglected to apply for them within the prescribed period, may obtain them by purchase at a price to be hereafter fixed. Fellows who desire the Index should notify their wish by letter, enclosing 1*s.* for cost of distribution, &c., to the Assistant-Secretary, Mr. Robert Steele, Chemical Society, Burlington House, W., before 31st December, 1895. For Fellows resident abroad, who should remit 2*s.*, which may be paid with their annual contribution, the time will be extended to 1st March, 1896.

A few copies of Vol. I (1841—72) can still be obtained, price 3*s.*, post free.

At the next meeting, on Thursday, December 19th, the following papers will be read:—

"The liquefaction of Air and its employment in researches at low Temperatures" (experimentally illustrated), by Professor Dewar, F.R.S.

"Constitution of Terpenes and Camphor" (Discussion).

"Derivatives of Dimethylaniline," by Miss Evans, B.Sc.

HARRISON AND SONS, PRINTERS IN ORDINARY TO HER MAJESTY, ST. MARTIN'S LANE.

Issued 14/1/1896.

PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

EDITED BY THE SECRETARIES.

No. 158. Session 1895–96.

December 19th, 1895. Mr. A. G. Vernon Harcourt, President, in the chair.

Messrs. E. H. Hills, Philip J. Hartog and Edgar S. Hanes were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. W. H. Barker, 26, Belgrave Road, Longton, Staffs.; Maurice Blood, 15, Clyde Road, Bristol; James Craig, 6, Montague Street, Gt. Western Road, Glasgow; Charles James Pemeller Fuller, Mona House, Horwich, Lancs.

Of the following papers those marked * were read :—

*151. " The liquefaction of air and research at low temperatures." By James Dewar, LL.D., F.R.S.

The author reviewed all the forms of apparatus that had been used in low temperature research, pointing out that the best and most economical plant for the production of liquid air or oxygen was one based on the general plan of the apparatus used by Pictet in his celebrated experiments on the liquefaction of oxygen in the year 1878. Instead of using Pictet's combined circuits of liquid sulphur dioxide and carbon dioxide maintained in continuous circulation by means of compression, liquefaction, and subsequent exhaustion, it has been found preferable to select ethylene after Cailletet and Wroblewski, for one circuit, and to join with it either nitrous oxide, or, better, carbon dioxide. Further, instead of making the oxygen to be liquefied by heating potassium chlorate in an iron bomb directly connected with the refrigerator, and thereby reaching high gas pressures, it has been found more convenient to use gas previously compressed in steel cylinders. The stopcock that Pictet employed to draw off liquid and produce sudden expansion was in his apparatus placed outside the refrigerator proper, but it is now placed inside, so as to be kept cool by the gases undergoing expansion. This improvement was introduced along with that of isolating the liquid gases by surrounding them with their own vapour in the apparatus made wholly of copper, described and figured in the *Proc. Roy. Inst.* for 1886. In all continuously working circuits of liquid gases used in refrigerating apparatus the regenerative principle applied to cold first introduced by Siemens, in 1857, and subsequently employed in the freezing machines of Kirk, Coleman, Solvay, Linde, and others has been adopted. Quite independently, Professor Kamerlingh Onnes, of Leiden, has used the regenerative principle in the construction of the cooling circuits in his cryogenic laboratory (see Paper by Dr. H. Kamerlingh Onnes, on the "Cryogenic Laboratory at Leiden. and on the Production of very low Temperatures," Amsterdam Akademie, 1894). Apart, therefore, from important mechanical details, and the conduct of the general working, nothing new has been added by any investigator to the principles involved in the construction and use of low temperature apparatus since the year 1878. The *Phil. Mag.* of February, 1895, contains a fantastic claim put forward by Professor Olszewski, of Cracow, that because he used in 1890 a steel tube combined with a stopcock to draw off liquid oxygen, he had taught the world, to use his own language, "the method of getting large quantities of liquid gases." But when, in addition, Olszewski alleges, four years after the event, that the experiments made at the Royal Institution since 1891 are chiefly borrowed from Cracow, and that he is entitled to the credit of all low temperature research subsequent to 1891, because of his steel tube and stopcock invention, one can only wonder at the meagre additions to knowledge that in our time are unhesitatingly brought forward as original, and more especially that scientific men could be got to give them any currency in this country. Such persons should read the late Professor Wroblewski's pamphlet, entitled "Comment l'air a été liquefié" (Paris, Libraire du Luxembourg, 1885), and make themselves generally acquainted with his work before coming to hasty conclusions on claims of priority brought forward by the Professor of Chemistry at Cracow.

Liquefying Apparatus.—The author proceeded to describe the construction and show the working of a laboratory apparatus for the production of liquid oxygen and other gases, represented in section (Fig. 1). With this simple arrangement 100 c.c. of liquid oxygen can readily be obtained, the cooling agent being carbon dioxide, at the

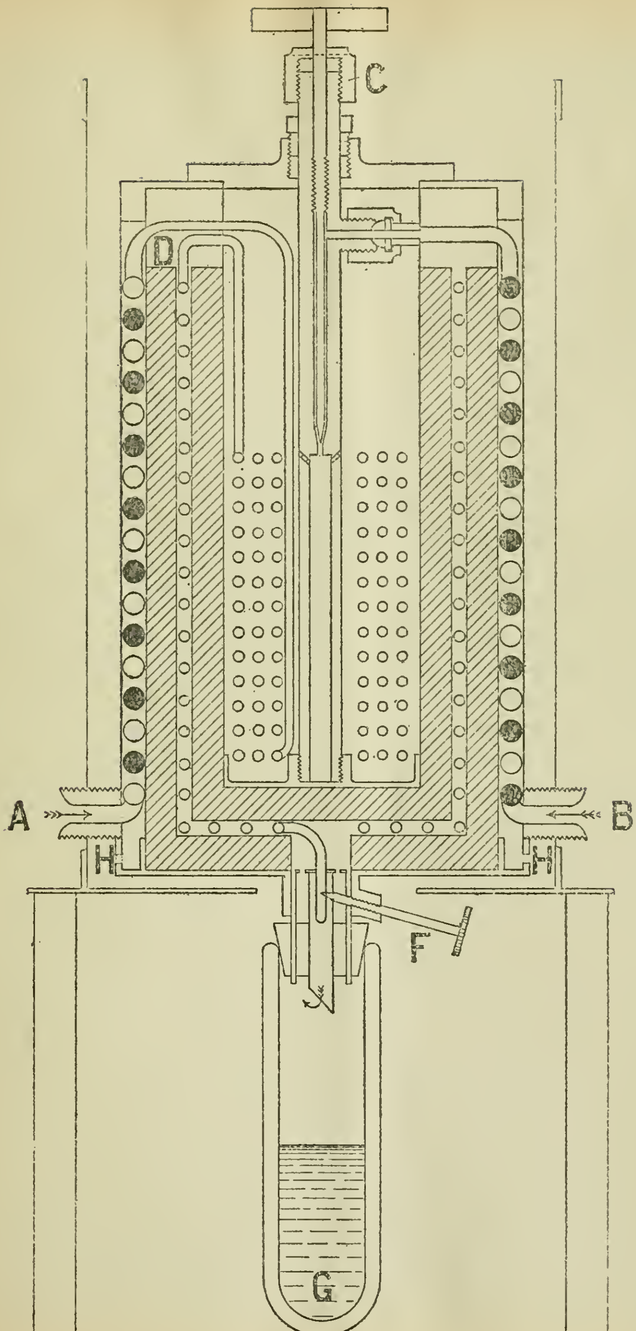


FIG. 1.—A, air or oxygen inlet; B, carbon dioxide inlet; C, carbon dioxide valve; D, regenerator coils; F, air or oxygen expansion valve; G, vacuum vessel with liquid oxygen; H, carbon dioxide and air outlet; ○, air coil; ●, carbon dioxide coil.

temperature of —79°, no exhaustion being used. The gaseous oxygen, cooled before expansion by passing through a spiral of copper tube immersed in solid carbon dioxide, passes through a fine screw stopcock under a pressure of 100 atmos., and thence backwards over the coils of pipe. The liquid oxygen begins to drop in about a quarter of an hour from starting. The general arrangement of the circuits will be easily understood from the sectional drawing. The pressure in the oxygen cylinders at starting is generally about 150 atmos., and the best results are got by working down to about 100. This little apparatus will enable liquid oxygen to be used for demonstration and research in all laboratories.

Vacuum Vessels.—It has been shown in previous papers* that a good exhaustion reduces the influx of heat to one-fifth part of what is conveyed when the annular space in such double-walled vacuum vessels is filled with air. If the interior walls are silvered, or excess of mercury is left in the vessel, the influx of heat is diminished to one-sixth part of the amount entering without the metallic coating. The total effect of the high vacuum and silvering is to reduce the ingoing heat to 1/30th part, or, roughly, 3½ per cent. Vessels constructed with three dry air spaces only reduced the influx of heat to 35 per cent. An ordinary mercury vacuum vessel is therefore 10 times more economical for storing liquid air, apart from considerations of manipulation, than a triple annular-spaced air vessel. It has been suggested that the metallic coating of mercury does no good, because Pictet has found that all kinds of matter at low temperatures become transparent to heat. The results above mentioned dispose of this assumption, and direct experiment proves that no increase in the transparency of glass to thermal radiation takes place by cooling to the boiling point of air.†

Solid Air.—As Professor Olszewski has recently alleged that air does not solidify at the lowest pressures (*Phil Mag.*, February, 1895), the author's former experiments were repeated on a larger scale. If a litre of liquid air is placed in a globular silvered vacuum vessel and subjected to exhaustion, as much as half a litre of solid air can be obtained and maintained in this condition for half an hour. At first the solid is a stiff, transparent jelly, which, when examined in the magnetic field, has the liquid oxygen drawn out of it to the poles. This proves that solid air is a nitrogen-jelly containing liquid oxygen. Solid air can only be examined in a vacuum or in an atmosphere of hydrogen, because it instantly melts on exposure to the air, giving rise to the liquefaction of an additional quantity of air. It is strange to see a mass of solid air melting in contact with the atmosphere, and all the time welling up like a kind of fountain.

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* "On Liquid Atmospheric Air," *Proc. Roy. Inst.*, 1893; "Scientific Uses of Liquid Air," *ibid.*, 1894.

† As this is passing through the press, I observe that M. Cailletet, at the last meeting of the French Academy (*Comptes Rendus*), presented a paper by M. Solvay of Brussels, in which my device of vacuum vessels is attributed to M. Cailletet, and tacitly accepted by him! In 1873 I had already used a highly exhausted vessel, of similar shape to the vacuous test tube, in calorimetric experiments. See paper on "The Physical Constants of Hydrogenium," Trans. Roy. Soc. Ed, vol. 27.

Samples of air liquefied in sealed flasks.—In a previous paper "On the relative behaviour of chemically prepared and of atmospheric nitrogen" PROC., December, 1894, the plan of manipulating such samples was described. Two flasks of dry air that had stood over phosphoric anhydride were liquefied side by side, the only difference between the samples being that one was free from carbonic acid. The one gave a liquid that was perfectly clear, the other was turbid from the 0·04 per cent. of carbon dioxide. The temperature was now lowered by further exhaustion of the liquid air surrounding the tubes until both liquids became solid. The flasks were then sealed off for the purpose of examining the composition of the air that had not been condensed. The one sample contained oxygen, 21·19 per cent., and the other 20·7 per cent. This is an additional proof to the one previously given, that, substantially, the oxygen and nitrogen in air liquefy simultaneously, even under gradually diminishing pressure, and that in these experiments all the known constituents of air are condensed together. These results finally disproved the view expressed in *A System of Inorganic Chemistry* (1891, p. 70), by Professor Ramsay, where he says: "Air has been liquefied by cooling to −192°, but as oxygen and nitrogen have not the same boiling points, the less volatile oxygen doubtless liquefies first." In the author's former experiments, the substance now known as argon, became solid before nitrogen, but chemical nitrogen and air nitrogen, with its 0·1 per cent. of argon, behaved in substantially the same way on liquefaction.

Liquid nitric oxide.—Great interest attaches to the behaviour of nitric oxide at low temperatures. Professor Olszewski has examined the liquid and describes it as colourless. Dr. Scott has prepared in different ways samples of nitric oxide. These have been transferred to liquefaction flasks, where they were left in contact with potash, sulphuric acid, or phosphoric acid for many days before use. Each of the samples, when cooled, gave a nearly white solid, melting into a *blue liquid*. The colour is more marked at the melting point than at the boiling point. Liquid nitric oxide is not magnetic; neither is the solid phosphorescent. Colour in the oxides of nitrogen evidently begins with the second oxide. Solid nitric oxide does not show any chemical action in liquid oxygen, provided the tube containing it is completely immersed; but if the tube full of liquid oxygen is lifted into the air, almost instantly a violent explosion takes place.

Specific Gravities taken in liquid oxygen.—In a good vacuum vessel specific gravities may be taken in liquid oxygen with as great ease as in water.

Some 20 substances were weighed in liquid oxygen, and the apparent relative density of the oxygen determined. The results were then corrected, using Fizeau's values for the variation of the coefficient of expansion of the solids employed, and thereby the real density of liquid oxygen calculated. The resulting value was 1·1375, bar. 766·5, in the case of such different substances as cadmium, silver, lead, copper, silver iodide, calc-spar, rock crystal. Direct determinations with an exhausted glass cylindrical vessel displacing about 22 c.c. gave 1·1378. Fizeau's parabolic law for the variation of the coefficient of expansion holds down to −183°. The solid which showed the greatest contraction was a block of compressed iodine, the one that contracted least being a compressed cylinder of silver iodide. Wroblewski gave the density of liquid oxygen at the boiling point as 1·168, whereas Olszewski found 1·124. The variation of density is about ±0·0012, for 20 mm. barometric pressure. Much work requires to be done in the accurate determination of the physical constants of liquid gases.

Liquid Air.—A large silver ball weighed in liquid air gave the density of the latter as 0·910, and the corresponding density of nitrogen at its boiling point 0·850. It is difficult to be quite certain that the constituents of liquid air are in the same proportion as the gaseous ones, so that further experiments must be made. Liquid air kept in a silvered vacuum vessel gradually rises in boiling point from the instant of its collection, the rate of increase during the first hour being nearly directly proportional to the time. As the increase amounted to 1° in 10 minutes the boiling point of oxygen ought to have been reached within two hours. The density of liquid air, however, does not reach that of pure oxygen even after 30 hours' storage. The large apparatus can be arranged to deliver liquid air containing 49 per cent. of oxygen, which gives off gas containing 20 per cent. of oxygen, rising after six hours to 72·6 per cent.

Combustion in Liquid Oxygen.—A small ignited jet of hydrogen burns continuously below the surface of liquid oxygen, all the water produced being carried away as snow. There is a considerable amount of ozone formed, which concentrates as the liquid oxygen evaporates. In the same way graphite or diamond, when properly ignited, burns continuously on the surface of liquid oxygen, producing solid carbonic acid and generating ozone. If liquid oxygen is absorbed in wood charcoal, or cotton wool, and a part of the body heated to redness, combustion can start with explosive violence.

Gas jets containing liquid.—The experiments of Joule and Thomson and Regnault on the temperature of gas jets issuing under low pressures are well known. The following observations refer to the pressure required to produce a lowering of temperature sufficient to yield liquid in the gas jet.

The apparatus used in the study of highly compressed gas jets is represented in Fig. 2; where C is a vacuum tube which holds a coil of pipe about 5 mm. in diameter along with carbon dioxide or liquid air for cooling the gas before expansion, and A is a small hole in the silver or copper tube about $\frac{1}{5}$ mm. in diameter, which takes the place of a stopcock. When carbon dioxide gas at a pressure of 30 or 40 atmos. is expanded through such an aperture, liquid can be seen where the jet impinges on the wall of the vacuum tube along with a considerable amount of solid. If oxygen gas escapes from the small hole at the pressure of 100 atmos., having been cooled previously to −79° in the vessel C, a liquid jet is just visible. It is interesting to note in passing that Pictet could get no liquid oxygen jet below 270 atmos. This was due to his stopcock being massive and outside the refrigerator. If the oxygen is replaced by air no liquid jet can be seen unless the pressure is raised to 180 atmos. If the carbon dioxide is cooled by exhaustion (to about 1 mm. pressure) or −115°, then liquid air can easily be collected in the small vacuum vessel D, or if the air pressure is raised above 200 atmos., keeping the cooling at −79° as before. The chief difficulty is in collecting the liquid owing to the rapid current of gas. The amount of liquid in the gas jet is small and its collection is greatly facilitated by directing the spray on a part of the metallic tube above the little

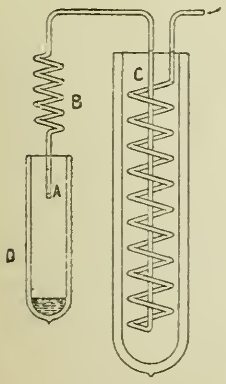


Fig. 2.

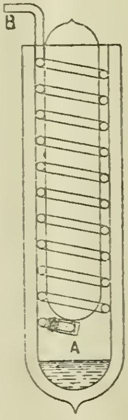
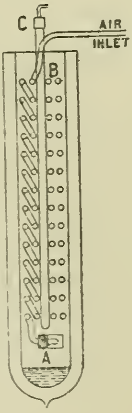


Fig. 3.



Fif. 4.

hole or by increasing resistance to the escaping gas by placing some few turns of the tube, like B in the figure, in the upper portion of the vacuum tube, or generally by pushing in more tube in any form. A vacuum vessel shaped like an egg-glass also works well. This practically economises the cool gas which is escaping to reduce the temperature of the gas before expansion, or, in other words, it is the cold regenerative principle. Coleman pointed out long ago that his air machine could be adapted to deliver air at as low a temperature as has yet been produced in physical research. Both Solvay and Linde have taken patents for the production of liquid air by the application of cold regeneration, but the latter has the credit of having succeeded in constructing an industrial apparatus (the plans of which are not yet published) that is lowered in temperature to —140°, or to the critical point of air in about 15 hours, and from which liquid air containing 70 per cent. oxygen is collected after that time.

For better isolation, the pipe can be rolled between two vacuum tubes, the outer one being about 9 inches long and $1\frac{1}{2}$ inch diameter, as shown in Fig. 3. The aperture in the metal pipe has a little piece of glass tube over it which helps the collection of the liquid. With such a simple apparatus and an air supply at 200 atmos. with no previous cooling, liquid air begins to collect *in about five minutes*, but the liquid jet can be seen in between two and three minutes. It is not advisable to work below 100 atmos.

In Fig. 4 the metallic tube in the vacuum vessel is placed in horizontal rings, leaving a central tube to allow the glass tube C to pass, which is used to cool bodies or examine gases under compression. The inner tube can be filled for an inch with liquid air under a pressure of 60 atmos. in about three minutes. Generally, in the experiments, about $\frac{1}{2}$ to 4 cubic feet of air passes through the different sized needle holes per minute when the pressure is about 200 atmos. As the small hole is apt to get stopped, for general working it is better to use a needle stopcock, worked from the outside by a screw passing through the middle of the coil of pipe. A double coil of pipe has advantages in the conduct of some experiments. The efficiency is small, not exceeding the liquefaction of 2 to 5 per cent. of the air passing, but it is a quick method of reaching low temperatures and easy to use for cooling tubes and collecting a few hundred c.c. of liquid air, especially if the compressed air is delivered at the temperature of —79° before expansion. With larger vacuum vessels and larger regenerating coils no doubt the yield of liquid could be increased. The liquid air resulting from the use of this form of apparatus contains about 50 per cent. of oxygen. If the air is cooled with solid carbonic acid previous to its reaching the vacuum tube coil of pipe, the only change is to reduce the percentage of oxygen to 40. Successive samples of liquid taken during the working had nearly the same composition. If the arrangement shown in Fig. 2 is used, with silver tube, about $\frac{1}{16}$ in. bore, and a foot or two coiled in upper part of the vacuum vessel, liquid air containing 25 per cent. of oxygen was obtained. On the other hand, the percentage of oxygen can be increased by a slight change in the mode of working.

In the above experiments air is taken at the ordinary temperature, which is a little above twice its critical temperature, and is partially transformed in a period of time which, in my experiments, has never exceeded 10 minutes, simply and expeditiously into the liquid state at its boiling point, −194°, or a fall of more than 200° has been effected in this short period of time.

Experiments on Hydrogen.—Wroblewski made the first conclusive experiments on the liquefaction of hydrogen in January, 1884. He found that the gas cooled in a tube to the boiling point of oxygen, and expanded quickly from 100 to 1 atmos., showed the same appearance of sudden ebullition as Cailletet had seen in his early oxygen experiments. No sooner had the announcement been made than Olszewski confirmed the result by expanding hydrogen from 190 atmos., previously cooled with oxygen and nitrogen in a vacuum. Olszewski declared in 1884 that he saw colourless drops, and by partial expansion to 40 atmos. the liquid hydrogen was seen by him running down the tube. Wroblewski could not confirm these results, his hydrogen being always what he called a "liquide dynamique." He proposed to get "static" liquid hydrogen by the use of hydrogen gas as a cooling agent. From this time until his death, in the year 1888, Wroblewski devoted his time to a laborious research on the isothermals of hydrogen at low temperatures. The data thus arrived at, enabled him by the use of Van der Waal's formulæ, to define the critical constants of hydrogen, its boiling point, density, etc., and the subsequent experiments of Olszewski have confirmed the accuracy of the results. In a paper published in the *Phil. Mag.*, September, 1884, "On the Liquefaction of Oxygen and the Critical Volumes of Fluids," the suggestion was made that the critical pressure of hydrogen was wrong, and that instead of being 99 atmos. (as deduced by Sarrau from Amagat's isothermals) the gas had probably an abnormally low value for this constant. This view was substantially confirmed by Wroblewski finding a critical pressure of 13·3 atmos., or about one-fourth that of oxygen. The *Chemical News* (September 7, 1894), contains an account of the stage the author's hydrogen experiments had reached at that date. The object was to collect liquid hydrogen at its boiling point, in an open vacuum vessel, which is a much more difficult problem than seeing the liquid in a glass tube under pressure and at a higher temperature. In order to raise the critical point of hydrogen to about −200° from 2 to 5 per cent. of nitrogen or air was mixed with it. This is simply making an artificial gas containing a large proportion of hydrogen, which is capable of liquefaction by the use of liquid air. The results are summed up in the following extract from the paper. "One thing can, however, be proved by the use of the gaseous mixture of hydrogen and nitrogen, viz., that by subjecting it to a high compression at a temperature of −200° and expanding the resulting liquid into air, a much lower temperature than anything that has been recorded up to the present time can be reached. This is proved by the fact that such a mixed gas gives, under the conditions, a paste or jelly of solid nitrogen, evidently giving off hydrogen because the gas coming off burns fiercely. Even when hydrogen containing only some 2 to 5 per cent. of air is similarly treated the result is a white, solid matter (solid air) along with a clear liquid of low density, which is so exceedingly volatile that no known device for collecting has been successful."

In Professor Olszewski's paper "On the Liquefaction of Gas" (*Phil. Mag.*, 1895,), after detailing the results of his hydrogen experiments, he says, "The reason for which it has not hitherto been possible to liquefy hydrogen in a static state, is that there exists no gas having a density between that of hydrogen and nitrogen, and which might be, for instance, 7—10 (H = 1). Such a gas would be liquefied by means of liquid oxygen or air as cooling agent, and afterwards used as a recognised menstruum in the liquefaction of hydrogen." Science will probably have to wait a very long time before this suggestion of how to get "static" liquid hydrogen is realised. The proposal Wroblewski made in 1884 of using the expansion of hydrogen as a cooling agent to effect the change of state is far more direct and practicable.

Liquid Hydrogen Jet and Solid Oxygen.—Hydrogen, cooled to −194° (80° abs. *t.*) the boiling point of air, is still at a temperature which is two and a half times its critical temperature, and its direct liquefaction at this point would be comparable to that of air taken at 60°, and liquefied by the apparatus just described. Now, air supplied at such a high temperature greatly increases the difficulty and the time required for liquefaction. Still, it can be done, even with the air supply at 100°, in the course of seven minutes and this is the best proof that hydrogen, if placed under really analogous conditions, at −194° must also liquefy with the same form of apparatus. Hydrogen, cooled to −200°, was forced through a fine nozzle under 140 atmos. pressure, and yet no liquid jet could be seen. If the hydrogen contained a few per cent. of oxygen the gas jet was visible, and the liquid collected, which was chiefly oxygen, contained hydrogen in solution, the gas given off for some time being explosive.

If, however, hydrogen, previously cooled by a bath of boiling air, is allowed to expand at 200 atmos. over a regenerative coil similar to that shown in Fig. 2, but longer, a liquid jet can be seen after the circulation has continued for a few minutes along with a liquid which is in rapid rotation in the lower part of the vacuum vessel. The liquid did not accumulate, owing to its low specific gravity and the rapid current of gas. These difficulties will doubtless be overcome by the use of a differently shaped vacuum vessel and by better isolation. The liquid jet can, however, be used as a cooling agent like the spray of liquid air obtained under similar circumstances, and, this being practicable, the only difficulty is one of expense. In order to test in the first instance what the hydrogen jet could do in the production of lower temperatures, liquid air and oxygen were placed in the lower part of the vacuum tube just covering the jet. The result was that in a few minutes about 50 c.c. of the respective liquids were transformed into hard white solids resembling avalanche snow, quite different in appearance from the jelly-like mass of solid air got by the use of the air pump. The solid oxygen had a pale, bluish colour, showing by reflection all the absorption bands of the liquid. The temperatures reached and other matters will be dealt with in a separate communication. There is no reason why a spray of liquid hydrogen, at its boiling point in an open vacuum vessel, should not be used as a cooling agent in order to study the properties of matter at some 20° or 30° above the absolute zero. The sole difficulty is the cost.

Fluorine.—This is the only widely distributed element that has not been liquefied. Some years ago Wallach and Hensler pointed out that an examination of the boiling points of substituted halogen organic compounds led to the conclusion that, although the atomic weight of fluorine is 19 times that of hydrogen, yet it must in the free state approach hydrogen in volatility. This view is confirmed by the specific refractive index which Gladstone showed was rather lower than hydrogen. If the chemical energy of fluorine at low temperatures is abolished like that of other active substances, then some kind of glass or other transparent material not so brittle as calcium fluoride could be employed in the form of a tube, and its liquefaction achieved by the use of hydrogen as a cooling agent.

During the conduct of these investigations, able assistance has been rendered by Mr. Robert Lennox, whose name has been so often mentioned in the Royal Institution lectures. Valuable help has also been given by Mr. J. W. Heath, Assistant at the Royal Institution.

Discussion.

Professor Ramsay remarked that Professor Olszewski had succeeded in liquefying hydrogen, and from unpublished information received from Cracow, he was able to state that a fair amount of liquid had been obtained, not as a froth, but in a state of quiet ebullition, by surrounding a tube containing compressed hydrogen by another tube also containing compressed hydrogen at the temperature of oxygen boiling at a very low pressure. On allowing the hydrogen in the middle jacket suddenly to expand, the hydrogen in the innermost tube liquefied, and was seen to have a meniscus. Its critical point and its boiling point, under atmospheric pressure, were determined by means of a resistance thermometer. There would appear to be no difficulty in distinguishing the meniscus of hydrogen, where the liquid is 50 times as heavy as the gas, for it is perfectly easy to see a meniscus with such a liquid as ether, at temperatures so near the critical point that the liquid has only three or four times the density of the gas.

Mr. BLOUNT said that the first account of the Linde process for liquefying air had been published in the early autumn of 1895 in the form of a paper read by Herr Schrötter before the Association of German Engineers at Aachen. Briefly, it consisted in taking advantage of the fact that air, not being a perfect gas, is permanently cooled when allowed to expand through a narrow opening without doing external work. The lowering of temperature was expressed by Joule and Thomson's formula, $t = \frac{p_2 - p_1}{4}\left(\frac{289}{T_1}\right)^2$, where t is the fall in temperature in degrees centigrade p_2 is the pressure of the air before it passes the opening, p_1 is the pressure of the air after passing the opening, and T_1 is the absolute temperature of the air before passing the opening. The effect was made cumulative by causing the air thus cooled to cool that which was about to pass through the opening. This was effected by the use of two long concentric tubes, the inner conveying the air to be cooled, and the annular space between the two being traversed by the cooling air. Circulation was maintained by means of an ordinary air compressor, and the temperature fell until the critical temperature was reached. A subsidiary compressor supplied fresh air to the cycle to replace that liquefied. The process was interesting because it differed fundamentally from those usually employed for the liquefaction of difficultly condensible gases, in two respects, viz. (1) it dispensed with the use of intermediate cooling agents, and (2) it applied a method for the cumulative withdrawal of heat analogous to the converse process of heat regeneration. Trials of the process had been made on a considerable scale, and there appeared to be no difficulty in liquefying air cheaply and in quantity.

Lord PLAYFAIR said, as a Past-president of the Society he was aware that it is not the practice to move a vote of thanks to the reader of a paper, so that he must not conclude with a motion to that effect But he was sure that he was expressing the sentiments of all present, when he said that they were grateful for the admirable exposition and splendid experiments which they had heard and seen. It is known to them all that an undesirable controversy had been going on as to how much originality there is in the researches of Professor Dewar, whom he had the honour of claiming as an old student and assistant when he was Professor in Edinburgh. He had wasted his time in reading these attacks, and they have had no influence on his mind, or rather that they had influenced him to send a subscription to the Royal Institution towards the cost of the apparatus. The diagram of Pictet's apparatus, now shown, certainly gives to the general chemist the most original conceptions as to how the problem of liquefying gases should be attacked. But if Pictet were now with them, and could see the great advances which had been made on his ideas, he would be the first to recognise their importance, and to congratulate Professor Dewar. It is only in mythology that Minerva full grown, and panoplied in complete armour, is born from the brain of Jupiter after a prolonged gestation. In human brains one discovery suggests another, and we proceed to the goal of knowledge step by step. The world now feels that Watt's discoveries, in improving the steam-engine, gave an enormous impulse to civilization. But the men of his day were petty enough to deny him merit, and they went to a court of justice to prove that every one of his discoveries had previously been made by other men, and more strange still, the court agreed with them and solemnly declared that Watt had done nothing to improve the steam-engine. Every discovery can be connected with previous discoveries. Would the merit of Rayleigh and Ramsay be lessened as the discoverers of argon because Cavendish had it undoubtedly as the residue in his tube in his famous experiment on air? It is to be hoped that Professor Dewar will go on with his magnificent experiments on the liquefaction of gases, and with the researches which come from them, without caring for the mosquitoes of science which buzz about his ears.

Dr. ARMSTRONG said that, after what had fallen from Lord Playfair, he would venture to express the opinion that the attacks made on Professor Dewar during the past few months were disgraceful. In these days we should encourage as far as possible all who were engaged in such dangerous and difficult work, not decry their labours. The history of the Royal Institution in the past, in so far as concerned the liquefaction of gases, was a glorious one, and he had no doubt that when the work done there more recently came to be considered without prejudice, it would be regarded as equally important. In fact there was evidence of this already. Professor

Onnes, of Leiden, who, with most limited appliances and means, had already accomplished so much in the field of research at low temperatures—an acknowledged expert in these matters—in a recent publication, in which justice was done to all workers, clearly recognised that much credit was due to Professor Dewar for his various improvements. He did not consider it necessary to thank Professor Dewar, but thought that his assistants should not be forgotten. Messrs. Lennox and Heath, had done much service in connection with the work generally, and especially in making the present demonstration possible.

Professor Dewar, in reply, stated that he could have no knowledge of unpublished work on the liquefaction of hydrogen. The mere fact of liquefaction was first definitely given by Wroblewski, although Cailletet had made an earlier experiment of the same kind. His paper contained a quotation from Professor Olszewski's communication made to the *Philosophical Magazine* in February, 1895, in which Olszewski distinctly says that he had not succeeded in getting liquid hydrogen in the "static" condition. Further, in a later paper, published in the same journal, for August, 1895, no mention is made of getting a "fair amount of liquid in a state of quiet ebullition" or of seeing a "meniscus." Even the method of working, to which reference has been made, is not mentioned, far less the result of the experiments made by the speaker in 1894. He was unable to understand why such a point should be made of seeing a meniscus, considering that the liquid can be seen. The remarks about the difficulty of separating liquid hydrogen from the gas had reference to a fine rain of fluid in a rapidly rushing stream of gas passing through vacuum vessels, and has no relation whatever to critical point phenomena to which reference had been made. If the liquid oxygen and air-jets shown have any resemblance to the Linde apparatus described by Mr. Blount, chemists, for once, may be congratulated that a small laboratory apparatus works in some respects better than a large industrial plant. The Linde apparatus after working 15 hours is capable of reducing the temperature of air to its critical point, whereas in the present small apparatus liquid air is produced in five minutes. Such a process cannot replace the use of "cooling agents" when considerable quantities of liquid air have to be produced in a short period of time as in ordinary laboratory work. It is a mistake to attribute to Linde the idea of using the "cumulative withdrawal of heat," for the first time, in his apparatus but he has succeeded in making a workable industrial machine and that is a very important step. The late Professor Wroblewski, as early as the year 1884, predicted that liquid air would be the refrigerating agent of the future; his prophecy seems about to be realised.

152. "Researches on tertiary benzenoid amines. I. Derivatives of dimethylaniline." By Clara de Brereton Evans, B.Sc.

It is now established in the case of primary and secondary benzenoid amines, that the production of derivatives containing a substituent in the hydrocarbon nucleus is often preceded by that of the corresponding derivative in which the substituent is present in the amino-group; and inasmuch as compounds of the latter readily pass over into those of the former class, it is not improbable that their formation is a necessary step in that of many derivatives of benzenoid amines. As it is impossible, however, that similar derivatives should be formed from tertiary amines, the behaviour of these is of interest as throwing light on the influence which nitrogen itself exercises; and that this may be altogether different from that of nitrogen associated with hydrogen is clear from a comparison of benzenoid amines with *azophenes* (compare Proc., 1892, 128) such as pyridine and quinoline, as these latter manifest a comparative indifference towards agents generally which is quite remarkable.

The experiments to be described have brought to light the fact that tertiary benzenoid amines manifest a somewhat similar indifference.

Dimethylaniline is readily sulphonated by means of chlorosulphonic acid, yielding only the *para*-acid; it is somewhat less readily, but yet easily sulphonated by means of a *single* molecular proportion of ordinary sulphuric acid, but if a larger proportion of acid be used, the action takes place less readily, sulphonation being incomplete at the end of *twelve hours* at 180° when 5 molecular proportions of acid are used, although it is complete within *five hours* when a single proportion is taken. Practically nothing but the para-acid is formed. To procure the meta-acid, it would seem that it is necessary to use fuming sulphuric acid—a point of some interest in connection with the moot question as to the manner in which isomeric sulphonic acids are generated. The behaviour of diethylaniline is similar to that of dimethylaniline.

The behaviour of the para-acid towards bromine is remarkable. It first yields a *monobromo*-acid. On adding bromine to a solution of this bromo-acid in muriatic acid, a crystalline orange-coloured perbromide, $C_6H_3Br(NMe_2)(SO_3H)\cdot Br_2$, is precipitated. This is readily and simply deprived of its bromine by exposure to air, by boiling with water, and in contact with ammonia, sulphurous acid or potassium iodide. If digested with muriatic acid on the water bath in a closed vessel, it yields a small amount of tribromomethylaniline and some tetrabromodimethylaniline, together with much unchanged monobromo-acid; if digested with excess of bromine, it is entirely converted—but by no means easily—into tetrabromodimethylaniline. Under no condition, apparently, does it yield a dibromosulpho-acid or tribromodimethylaniline; in this respect its behaviour is most remarkable in comparison with that of ordinary sulphanilic acid, which is extremely sensitive to the action of bromine, being very readily converted into tribromaniline.

The meta-acid, in like manner, readily yields a parabromo-acid identical with that obtained on sulphonating parabromodimethylaniline, and this is converted into a dibromo-acid by the further action of bromine. But all attempts to prepare a tribromo-acid corresponding to that which is so readily obtained from anilinemetasulphonic acid were unsuccessful. No perbromide is obtained from the metabromo-acids.

On nitration with nitric acid, dimethylanilineparasulphonic acid yields a mixture of orthoparadinitrodimethylaniline, together with orthonitroparasulphonic acid, the latter being the chief product. The meta-sulphonic acid yields a dinitrosulphonic acid. On warming a solution in dilute acetic acid of the orthonitroparasulphonic acid with bromine, a substance crystallising in red prisms, melting at 102°, is produced, which apparently is a bromonitromethylaniline.

The behaviour of the diethylanilinesulphonic acids is similar to those of dimethylaniline. The perbromide derived from the bromoparasulphonic acid is better characterised even than that derived from the dimethylated acid.

A full description of the various compounds referred to in this note will be given in a complete paper; it may be stated that all are exceedingly well defined substances.

Experiments are in progress having for their object the comparison of the ortho-acids of dimethyl- and diethylaniline with the isomeric meta- and parasulphonic acids; and others are being made with the secondary amines to ascertain if their behaviour be, as is probable, similar to that of primary amines rather than intermediate between that of primary and tertiary. It is also proposed to largely extend these observations to other tertiary aminobenzenoid compounds, such as the dimethyltoluidines, dimethylamidophenol and dimethylamidobenzoic acid.

For the supply of a large quantity of material used in these experiments, Dr. Armstrong is indebted to the *Société pour l'Industrie Chimique à Bâle.*

153. "Experiments on the formation of the so-called ammonium amalgam." By James Proude and W. H. Wood, F.I.C.

The fact, first clearly established by Wetherill, that sodium amalgam does not form the so-called ammonium amalgam when added to an aqueous solution of ammonia, enables sodium amalgam to be used as a test for the presence of ammonium salts, even in the presence of ammonia.

Solutions of phenol and of pyrogallol in aqueous ammonia were shown to contain compounds of the nature of ammonium salts; whilst sodium phosphate, calcium chloride, and magnesium sulphate, with aqueous ammonia, gave rise to no mercurial froth, showing absence of ammonium salts.

Ammonium sulphate, nitrate, and acetate when fused gave no mercurial froth on the addition of sodium amalgam. Ammonium chloride, oxalate, acetate, benzoate, tartrate, and succinate, dissolved in absolute alcohol, rectified spirit, and methylated spirit, in no case gave a definite mercurial froth with the sodium amalgam, either cold or hot, though the acetate and benzoate dissolved in rectified spirit, and the chloride in methylated spirit, showed indications of swelling of the mercury. Water, therefore, appears to be necessary to the production of a definite froth.

The sp. gr. of the well-formed mercurial froth is not higher than 0·730, since it floats in methylated ether of that density.

154. "The molecular volumes of organic substances in solution." By W. W. J. Nicol, M.A., D.Sc.

In 1883, and again in 1892, the author directed attention to the probability that a study of the molecular volumes of organic substances in solution would lead to results from which the atomic volumes of the various elements could be determined with an ease and accuracy impossible by Kopp's method of determining the volume at the boiling point.

The paper contains an account of determinations made on 14 esters in dilute solution in various solvents. The chief conclusions drawn are as follows:—

1. The volumes of isomeric esters are approximately the same.
2. The volume of CH_2 is a constant for each solvent, being 16·8 in xylene, 17·0 in benzene, 17·3 in 88 per cent. alcohol, except
3. In the case of ethyl oxalate and succinate, where the value is about a unit less, owing probably to contraction resulting from the separation of the two carboxyl groups.
4. The nature of the solvent has a marked effect on the molecular volume, which is less in the solvent with the higher molecular weight.

155. "2 : 1 β-Naphthylaminesulphonic acid and the corresponding chloronaphthalenesulphonic acid." By Henry E. Armstrong and W. P. Wynne.

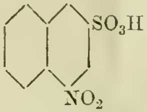
Tobias has recently shown (Germ. Pat., 74,688, February 19, 1893) that the acid obtained by one of us (Armstrong, *Ber.*, **15**, 1882, 202) by the action of chlorosulphonic acid on β-naphthol at the ordinary temperature is not β-naphthylsulphuric acid, $C_{10}H_7 \cdot O \cdot SO_3H$, but the isomeric 2 : 1-β-naphtholsulphonic acid, and in the same patent has described the amido-acid obtained by heating the hydroxy-acid with strong aqueous ammonia under pressure at 220—230°. Being desirous of examining the amido-acid, the authors applied to Dr. Tobias for a sample, and he not only sent them a carefully purified specimen of the sodium salt of the β-naphthylaminesulphonic acid, but courteously forwarded their letter to the Farbwerke vorm. Meister, Lucius and Brüning, who, with characteristic liberality, furnished them with a considerable quantity of the technical product. After purification, the acid was found to have all the characters described in the patent; its sodium salt, as there stated, crystallises from dilute alcohol in monohydrated scales.

The acid was converted by the Sandmeyer method into the corresponding 2 : 1-β-*chloronaphthalenesulphonic acid*, which has not hitherto been described, and is the twelfth of the fourteen isomerides which it is theoretically possible to isolate. This acid yields an easily soluble, mono-hydrated, microcrystalline *barium* salt, a monohydrated *potassium* salt crystallising in thin scales, and a monohydrated *sodium* salt crystallising in long, slender needles. The *chloride*, $Cl \cdot C_{10}H_6 \cdot SO_2Cl$, crystallises from a mixture of benzene and light petroleum in large, tabular forms, and from acetic acid in diamond-shaped scales melting at 76°; it yields an *amide* crystallising in slender needles melting at 153°, and on distillation with phosphorus pentachloride is converted into 1 : 2-dichloronaphthalene, melting at 35°.

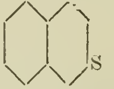
On sulphonation with four times its weight of cold 20 per cent. anhydrosulphuric acid, the 2 : 1-β-naphthylaminesulphonic acid is converted into the 2 : 1 : 4′-β-naphthylaminedisulphonic acid, previously described by the authors as the minor product of sulphonation of the Dahl 2 : 4′-β-naphthylaminesulphonic acid under similar conditions (Proc., 1890, 129).

The investigation of the 2 : 1-β-naphthylaminesulphonic acid and its derivatives is being continued.

156. "1 : 3-α-Naphthylaminesulphonic acid and the corresponding chloronaphthalenesulphonic acid." By Henry E. Armstrong and W. P. Wynne.

In the course of their study of the formation of isomeric naphthalene derivatives, the authors had occasion to attempt the repetition of Cleve's work on the nitration of naphthalene-β-sulphonic acid, since of the three acids obtained by him in this way, one was stated to have the constitution 

, the other two being the isomeric heteronucleal α-nitro-acids. Whilst successful in obtaining two heteronucleal acids, of which they determined the constitution, they were unable to prepare the homonucleal compound by the nitration of potassium naphthalene-β-sulphonate (Proc., 1889, 17). Particular interest attached to the question whether this acid was formed, inasmuch as—to repeat the words used at the time—"it has always been found that a heteronucleal α-derivative is formed in cases in which the corresponding benzene derivative would afford a meta-derivative." Although thus unsuccessful, they were, as they then said, "loth to accept the apparently logical interpretation of their results, as they were unacquainted with the precise conditions under which Cleve worked . . . . and as it is within their own experience that slight variations in treatment, such as may escape notice, may materially affect the result," and expressed the hope that Cleve would supply further details as to the procedure adopted by him. Subsequently it came to their knowledge that the homonucleal acid also could not be detected in the product obtained on nitrating sodium naphthalene-β-sulphonate on the large scale. Moreover, Erdmann and Süvern have failed to obtain the corresponding chloride by nitrating naphthalene-β-sulphonic chloride (*Annalen*, **275**, 252).

It is particularly instructive, therefore, to record the fact that the so-called [γ-] naphthylaminesulphonic acid which Cleve prepared by reducing the homonucleal nitro-acid he obtained by nitrating sodium naphthalene-β-sulphonate (*Ber.*, **19**, 2179; **21**, 3271) is identical with the 1 : 3-α-naphthylaminesulphonic acid of Kalle and Co.'s German Patent 64979, prepared from α-naphthylamine-[ϵ-]-disulphonic acid—which the authors have shown has the constitution 

(Proc., 1890, 15)—by partially hydrolysing it with diluted sulphuric acid, and which, as Friedländer has recently shown, may also be obtained by partially reducing the said disulphonic acid with sodium amalgam (*Ber.*, **28**, 1951).

Through the kind offices of Dr. Hepp. the authors are much indebted to Messrs. Kalle and Co. for a supply of this acid in the pure form; the experiments they have made with it confirm Cleve's statements as to the properties of this acid and the derived 1 : 3-α-chloronaphthalenesulphonic acid in every particular. There is nothing to add to the description of the salts of the amido- and chloro-acids as given in Cleve's later paper, but the authors have been able to carry the identification of the acids a stage further, since they find that the dichloronaphthalene, melting at 61·5°—obtained from the chloronaphthalenesulphonic chloride melting at 106°—on sulphonation gives products characteristic of 1 : 3-dichloronaphthalene (Proc., 1890, 82) and not of the 1 : 2′-isomeride of about the same melting point with which it was for a while confused.

157. "Studies on the constitution of tri-derivatives of naphthalene, No. 15. The disulphonic acids obtained by sulphonating 1 : 3-α-naphthylamine- and 1 : 3-α-chloronaphthalene-sulphonic acids." By Henry E. Armstrong and W. P. Wynne.

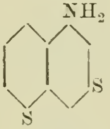
As already announced (Proc., 1890, 18, 131, 133; *Brit. Assoc. Report*, 1893, 382, footnote), the authors are engaged on experiments having for their object the determination of the comparative influence exercised by the radicles Cl, OH and NH_2 in naphthalene derivatives on the formation of disulphonic acids. Certain results arrived at in the case of β-derivatives have already been communicated (Proc., 1890, 128, *et seq.*), but progress with the work was retarded so long as the characteristics of the reference compounds —the trichloronaphthalenes—were in doubt. The fourteen theoretically possible isomerides being now known and characterised (Proc., 1895, 84), the authors hope shortly to complete their investigation of the products obtained on sulphonating the known naphthylamine- and chloronaphthalene-sulphonic acids. In the meanwhile, in view of the interest attaching to the 1 : 3-α-naphthylaminesulphonic acid, they think it well to put on record the results obtained on sulphonating it and the corresponding chloro-acid, so far as their experiments have gone.

When dry 1 : 3-α-naphthylaminesulphonic acid is stirred into four times its weight of 20 per cent. anhydrosulphuric acid at a temperature not exceeding 20°, it is converted in the course of 12 hours into what appears to be a single disulphonic acid. The normal potassium salt being very soluble, the acid was isolated in the form of the dihydrated *acid potassium* salt, which crystallised in radiate groups of short, brittle needles. On reduction by the hydrazine method it gave naphthalene-1 : 2′-disulphonic acid (Proc., 1890, 126) since the *chloride* obtained from it crystallised from acetic acid in glistening scales, melting at 122°, convertible by phosphorus pentachloride into

1 : 2′-dichloronaphthalene melting at 63·5°, and giving on sulphonation the characteristic chloride melting at 117° when opaque (Proc., 1890, 83). By the Sandmeyer process, it was converted into a chloronaphthalenedisulphonic acid, the *chloride* of which, $Cl\cdot C_{10}H_5(SO_2Cl)_2$, crystallised from a mixture of benzene and light petroleum in radiate groups of prismatic needles, and from acetic acid in small prisms, melting at 130°, which on distillation with phosphorus pentachloride gave 1 : 3 : 4′-trichloronaphthalene crystallising from alcohol in long, slender, flat needles, melting at 103°.

When dry potassium 1 : 3-α-chloronaphthalenesulphonate is sulphonated under the conditions described in a previous note (Proc., 1890, 131) by adding it to the theoretical quantity of sulphuric anhydride used in the form of 20 per cent. anhydrosulphuric acid and heating the warm mixture at 100° for an hour, it is converted into a *chloronaphthalenedisulphonic acid* identical with that just described. No trace of an isomeric acid was detected. As in previous cases, details as to the composition of the salts, &c., are reserved for the complete paper.

It follows, therefore, that, under the conditions described, the disulphonic acids obtained both from the 1 : 3-α-amido- and the 1 : 3-α-chloro-monosulphonic acids have a corresponding constitution expressed by the symbols



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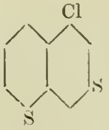

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HELMHOLTZ MEMORIAL LECTURE.

The Helmholtz Memorial Lecture will be delivered by Professor G. F. Fitzgerald, F.R.S., at an extra meeting of the Society to be held on Thursday, January 23, 1896, at 8 P.M.

At the next meeting, on Thursday, January 16th, the following papers will be read:—

"The acetylene theory of the luminosity of hydrocarbon flames." By Professor Vivian B. Lewes.

"The action of sodium alcoholate on the acid amides." By J. B. Cohen, Ph.D., and W. H. Archdeacon, B.Sc.

"Note on the electrolytic conductivity of formanilide and thioformanilide." By T. Ewan, B.Sc., Ph.D.

"Action of sugars on ammoniacal silver nitrate." By James Henderson, B.Sc.

"Solution and diffusion of certain metals in mercury." By W. T. Humphreys.

"On some of the ethereal salts of active and inactive monobenzoyl, dibenzoyl, diphenyl, acetyl, and dipropionyl-glyceric acids." By Professor Percy Frankland. F.R.S., and J. MacGregor, M.A.

"On the rotation of optically active bodies in organic solvents." By Professor Percy Frankland, F.R.S., and R. H. Pickard, B.Sc.

"The action of hydrogen chloride on ethyl alcohol." By J. C. Cain, D.Sc.

"Transformation of the alkyl ammonium cyanates into the corresponding ureas." By Professor Walker, D.Sc., and James R. Appleyard.

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Dec. 4, 1873		Baynes, James, jun., Ph.D., F.R.M.S., Borough Analyst's Office, Royal Chambers, Scale-lane, Hull
Feb. 19, 1891	Trans.	Beadle, Clayton, Beadonwell, Belvidere, Kent
Feb. 7, 1861		‖Beadnell, Major Charles Edward, R.A., 48, Castletown-road, W. Kensington
Dec. 5, 1867		Beale, William Phipson, Q.C., 10, New-court, Carey-street, Lincoln's-inn, W.C.; and 19, Upper Phillimore-gardens, Kensington, W.
Mar. 3, 1864		‖Beanes, Edward, 119, Ashley-gardens, S.W.
Mar. 6, 1890		Beardmore, G. Russell, D.P.H. Camb., L.R.C.P. Lond., M.R.C.S. Eng., L.S.A., Warwick House, Upper-street, Islington, N.
April 21, 1887		Beasley, William C. T., B.A., Fermain, St. Leonards-on-Sea

Date of Election.		
April 17, 1890		Beck, Charles R., 15, Abbotsford-road, Redland, Bristol
April 2, 1874	Trans.	Beckett, George Henry, care of Alfred Nobel, Chemisches Laboratorium, San Remo, Italy
May 4, 1882		Beckett, John Hampden, Corbar Hill House, Buxton, Derbyshire
Feb. 6, 1879	Trans.	Bedson, P. Phillips, D.Sc., University of Durham, College of Physical Science, Newcastle-on-Tyne
Dec. 19, 1872	Trans.	||Beilby, George T., St. Kitts, Slateford, N.B.
Dec. 6, 1888		Belcher, John Hope, B.A., Science School, Lincoln
May 7, 1891		Bell, Albert Edward, F.I.C., 2, Ellington-villas, Sherborne, Dorset
Dec. 2, 1886	Trans.	Bell, Chichester A., B.A., M.B. (Dublin), 3, Mansfield-place, Richmond, Surrey
June 20, 1889		Bell, E. Wightman, Spalding
Jan 19, 1865		||Bell, J. Carter, the Cliff, Higher Broughton, Manchester
Dec. 3, 1863	Trans.	Bell, Sir Lowthian, Bart., F.R.S., Rounton Grange, Northallerton
Jan. 17, 1889		||Bell, Percy Carter, Technical Laboratory, 13, Park-row, New York
Dec. 4, 1879		Bemrose, Joseph, 56, St. Famille street, Montreal, Canada
Dec. 17, 1874		||Bendix, David, Sutherland Lodge, 371, Romford-road, Stratford, E.
Nov. 19, 1874		Benger, Frederick Baden, F.I.C., The Grange, Knutsford, Cheshire
Feb. 17, 1881		Benjamin, Marcus, A.M., Ph.D., 589, West End-avenue, New York
April 15, 1886		Bennert, Carl, Ph.D., Godesberg, Germany
Dec. 4, 1890		Bentz, Ernest, The Elms, Handforth, Cheshire
June 21, 1883		||Beringer, Cornelius, 9, West-end, Redruth
Feb. 16, 1882		Beringer, John J., Basset-road, Camborne, Cornwall
Mar. 6, 1890		Berncastle, Richard, 22, Aldridge-road Villas, Bayswater, W.
June 17, 1875		Bernstein, Ludwik, M.D., F.R.S.E., Lismore, New South Wales
June 15, 1893		Berridge, Douglas J. P., B.A. Oxon, The Laboratory, Malvern College
Feb. 16, 1888		Berridge, Henry Dudley, M.A., Fotheringhay, Oundle, Northamptonshire
Dec. 7, 1882		Berry, Edward E., Villa Rosa, Bordighera, Italy
Dec. 3, 1891		Berry, Thomas William, 7, Tanley-street, Stone, Staffordshire
Dec. 6, 1888		Berry, William, 7, Hampton-park, Redland, Bristol
Dec. 15, 1892		Bersusan, Arthur J., 13, Lansdowne-road, Kensington-park, W., and Box 411, G.P.O., Sydney, N.S.W.
Mar. 1, 1883	Trans.	Bevan, Edward J., 4, New-court, Lincoln's-inn, W.C.
Dec. 2, 1886		Bevan, John William, care of Sir James Murray and Co., Chemical Works, Temple-street, Dublin
Dec. 7, 1865		||Bickerdike, W. E., Clayton Grange, Wilpshire, near Blackburn
Feb. 18, 1875		Biggart, J. W., Chemical Laboratory, 29, Cathcart-street, Greenock

Date of Election.		
Mar. 7, 1872		Biggs, C. H. W., 140, Salisbury-court, Fleet-street, E.C., and Broomfield, Bromley, Kent
Mar. 16, 1882		Billing, Henry S., c/o Burnard & Alger, Ld., near Plymouth
Dec. 15, 1881		Bingley, John, Northampton
June 4, 1874		Bird, Henry, South Down House, Millbrook, near Plymouth
Feb. 15, 1894		Bird, William Rowland, 73, Albion-street, New Swindon, Wilts
May 20, 1875	Trans.	Bischof, Gustav, Prof., 16, Colville-square, Bayswater, W., and 4, Hart-street, Bloomsbury
April 17, 1879		Black, A. H., F.R.G.S., St. John's, Wakefield
Dec. 2, 1886		Blackburn, Thomas, Aruba Phosphaat Maatschappy, Curaçoa, West Indies
Dec. 18, 1879		Blackett, Cuthbert R., Prof., Laboratory, Swanston-street, Old County Court, Melbourne
March 5, 1885		Blades, Chas. Mountain, Bay Villa, Chester-road, Northwich, Cheshire
Dec. 6, 1883		Blair, Frank A., Broomfield, Melrose, N.B.
Mar. 6, 1890		Blake, Robert R. F., Chemical Department, Queen's College, Belfast
May 15, 1890		Blake, William Henry, 7, Grange-crescent, Sunderland
June 3, 1875		||Blanshard, Charles Thomas, M.A., F.I.C., The Firs, Summertown, Oxford
June 16, 1892		Bleckly, Arthur Sanderson, Thelwall Lea, near Warrington
Dec. 4, 1890		Blenkinsop, W. E. B., 15, Earlsfield-road, Wandsworth Common, S.W.
Feb. 19, 1891		Bloomer, Frederick John, F.I.C., 40, Summersfield-crescent, Rotton-park, Birmingham, and 15, Broderick-road, Upper Tooting
Mar. 6, 1890	Trans.	Blount, Bertram, Laboratory, Broadway, Westminster, S.W.
Feb. 2, 1888		Bloxam, Arthur G., F.I.C., The Goldsmiths' Institute, New Cross, S.E.
Dec. 20, 1883	Trans.	Bloxam, W. Popplewell, B.Sc. Lond., F.I.C., Royal Naval College, Greenwich, S.E.
Feb. 2, 1865	Trans.	Blunt, T. P., M.A., Tower-place, Shrewsbury
April 21, 1887		Blundstone, Edwin Richardson, B.A., Cornwall Lodge, Hampton Hill, Middlesex
June 3, 1875	Trans.	Blyth, Alexander Wynter, M.R.C.S., 17, Marlborough Hill, N.W.
May 5, 1892		Blyth, Frederic William George, 5, Berkeley-crescent, Bristol
May 5, 1892		Blyth, M. Wynter, Junr., 8, New-court, St. John's College, Cambridge.
Dec. 2, 1875		||Boake, A., Stratford, London, E.
Feb. 7, 1878		Bodmer, Richard, Analytical Laboratory, 16, Southwark-street, London, S.E
Dec. 6, 1888		Bohm, William Dunsmore, A.R.S.M., F.I.C., 49, Avenue-road, Acton, W.

Date of Election.		
Mar. 18, 1869	Trans.	‖Bolas, Thomas, Turnham-green, W.
Feb. 18, 1892		Bond, Frederick Fielding, M.D., Rosemary House, Rastrick, Yorks
June 17, 1858		Bond, F. T., M.D., Gloucester
Feb. 1, 1883		Bond, Henry C., M.A., Bromley Park School, Bromley, Kent
May 4, 1893	Trans.	Bone, William Arthur, Owen's College, Manchester
Feb. 16, 1893		Boone, W. T., 6, Mount Pleasant-road, South Tottenham, N.
Mar. 1, 1877		Borland, John, F.L.S., Etruria, Kilmarnock
April 17, 1884		Borland, W. D., Beacon Lodge, Green-street, Green, near Dartford, Kent
Mar. 17, 1881		‖Borns, Henry, Ph.D., 19, Alexandra-road, Wimbledon, S.W.
Feb. 2, 1861		‖Bosanquet, R. H. M., F.R.S., New University Club, St. James'-street, S.W.
Feb. 15, 1894		Bose, Prof. Chuni Lal, 24, Mohendro Bose's-lane, Calcutta
June 16, 1881		Bostock, G. H., Laurel Villa, Hildersthorpe, Birdlington Quay
Dec. 15, 1881	Trans.	Bothamley, Charles H., F.I.C., Taunton, Somerset
June 16, 1887	Trans.	Bott, William, Ph.D., Raffles Institution, Singapore
Mar. 6, 1873		Bottle, Alexander, 4, Godwyn-road, Dover
June 15, 1871		Bottomley, James, B.A., D.Sc., Homer-terrace, 220, Lower Broughton-road, Manchester
May 15, 1869		Bottomley, James T., M.A., F.R.S., F.R.S.E., 13, University Gardens, Glasgow
Dec. 2, 1886		Bottomley, W. Beecroft, Ph.D., 15, Lillyville-road, Fulham, S.W.
Feb. 15, 1894		Boul, William Good, M.A., Tideswell Grammar School, near Buxton
Dec. 3, 1891		Bovell, John R., Dodd's Botanical and Experimental Station, Barbados
April 20, 1865		‖Bowdler, A. C., 20, Wellington-street, Blackburn
Dec. 6, 1888		Bower, Frank, 37, Lansdowne-road, South Lambeth-road, S.W.
May 3, 1894		Bowes, Harry, 9, Union-terrace, Cheetham Hill, Manchester
Dec. 7, 1893		Bowman, Frederic Edmund, Mayfield, Knutsford, Cheshire
Nov. 6, 1862		Bowman, Frederick H., F.R.A.S., F.L.S., F.G.S., Mayfield, Knutsford, Cheshire
Dec. 16, 1869	Trans.	Bowrey, J. J., Kingston, Jamaica
Dec. 6, 1894	Trans.	Boyd, D. R., 6, Speedwell-road, Birmingham
April 15, 1869		‖Braby, Frederic, Bushey Lodge, Teddington
Mar. 2, 1876		‖Bradley, Nathaniel, Sunnyside, Whalley Range, Manchester
June 21, 1888		Bradshaw, Charles, 10, The Nook, Barber-road, Sheffield
Mar. 17, 1881		Braga, J. F., F.G.S., F.L.S., F.R.G.S., 1, Albert-villas, High-road, Chiswick
Dec. 6, 1894		Brame, J. S. S., Royal College of Science, South Kensington, S.W.

Date of Election.		
Nov. 20, 1890		Branson, Charles F., Frankfort House, West-side, Clapham Common, S.W.
Dec. 7, 1882		Branson, F. W., 14, Commercial-street, and Wynneholme, Fur. Headingley, Leeds
June 15, 1882	Trans.	Brauner, B.. Ph.D., University of Prague, Bohemia, and Brennte Gasse, 1, Prague, Bohemia
Dec. 6, 1883		Briant, Lawrence, 24, Holborn-viaduct, E.C.
Dec. 4, 1890		Brierley, John Thomas, 96, Bolton-road, Chorley, Lancashire
Dec. 7, 1893		Briggs, Harry Fielden, D.D.S., L.D.S., D.Sc., Tower House, White Ladies'-road, Clifton, Bristol
May 4, 1893		Briggs, John Frederick, c/o Messrs. Parry and Co., South Arcot, Nellikuppani, Madras Presidency
April 19, 1883		Briggs, T. Lynton, 357, Madison-street, Brooklyn, New York, U.S.A.
Dec. 18, 1884		||Briggs, William, 32, Red Lion-square, Holborn, W.C.
Feb. 6, 1890		Brindley, George F., Aluminium Company, Oldbury, near Birmingham
April 4, 1889		Broadbent, Harry, A.I.C., 125, Belle Vue-road, Leeds
Feb. 6, 1879		||Broadbent, John J., Ellesmere House, Patricroft, near Manchester
Feb. 1, 1883		Brock, John, J.P., 17, Abercromby-square, Liverpool
Feb. 16, 1893		||Brockbank, John Edwin, The Croft, Kirksanton, viâ Carnforth
Dec. 18, 1884		Brodie, Sir Benjamin V. S., Bart., Brockham Warren, Betchworth
Feb. 16, 1893		Brooke, Edward, West-court, Chalk, Gravesend, Kent
Dec. 16, 1886	Trans.	||Brothers, Horace Edward, Park-terrace, Tunstall
Jan. 17, 1884		||Brough, Bennett Hooper, A.R.S.M., F.I.C., F.G.S., 28, Victoria-street, S.W.
May 4, 1876	Trans.	Brown, Adrian John, 6, Alexandra-road, Burton-on-Trent
Dec. 5, 1867	Trans.	Brown, Dr. A. Crum, F.R.S., 8, Belgrave-crescent, Edinburgh
Mar. 17, 1870		Brown, David, 93, Abbey-hill, Edinburgh
June 18, 1891		Brown, Edward, 32, Courlandsky-street, St. Petersburg, and care of Wm. Brown, Heaton-street, Cleckheaton
Mar. 20, 1873	Trans.	||Brown, Frederic Douglas, Prof., B.Sc., Univ. Col., Auckland, New Zealand
Mar. 20, 1884		Brown, Frederick William
May 5, 1892		Brown, George Fitz, The Brougton Copper Company, Ditton, Copper Works, Widnes
June 17, 1880		Brown, Henry, Cannon Brewery, Watford, Herts
Jan. 19, 1871	Trans.	†Brown, H. T., F.R.S., 52, Nevern-square, Kensington, W.
Mar. 7, 1867	Trans.	||Brown, James Campbell, D.Sc., University College, Liverpool
Mar. 16, 1881		Brown, Joseph, Ashleigh House, Savile Town, Dewsbury
May 4, 1893		Brown, Ralph E., Perranporth, Truro, Cornwall
May 5, 1892		Brown, Reginald B., 16, Melbourne-road, Leicester
Feb. 19, 1891		Brown, Robert John, The Technical School, Stockport

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† Longstaff Medallist, 1894.

Date of Election.		
Dec. 18, 1884		Brown, William George, Ph.D., Department of Agriculture Washington. D.C.
Dec. 7, 1893		Browne, Frank, Government Civil Hospital, Hong Kong
Feb. 20, 1873		Brownen, George, 16, Althorpe-road, Upper Tooting, S.W.
Dec. 4, 1890		Brownsword, Frank, Thorn Villa, Heaton Moor, Stockport
Dec. 6, 1894		Bruce, James, 10, Selwood-terrace, Fulham-road, S.W.
Dec. 7, 1893		Brunton, John Dixon, Wire Mill, Musselburgh, near Edinburgh
June 21, 1877	Trans.	Buchanan, J. Y., F.R.S., 10, Moray-place, Edinburgh
May 4, 1893		Buchanan, Joshua, United Langlaaghe, G.M.Co., Limited, Box 1048, Johannesburg, S.A.R.
June 1, 1876		||Buckmaster, C. A., 16, Heathfield-road, Mill-hill Park, Acton, W.
Mar. 1, 1852	Trans.	||Buckton, G. B., F.R.S., Weycombe, Haslemere, Surrey
June 20, 1878		Budden, E. Russell, 11, Furnival-street, Holborn, E.C.
Dec. 20, 1842		Bullock, Lloyd, 3, Hanover-street, Hanover-square, W.
Feb. 2, 1888		Bunn, Peter Coulson, junr., 18 and 19, Fenchurch-street, E.C.
Dec. 3, 1891		Burford, Samuel Francis, Eastleigh, Queen's-road, Leicester
Feb. 15, 1894		Burgess, Herbert Edward, 16, Bloomsbury-street, W.C.
Dec. 5, 1889		Burgess, John, 7, Wellington-road, Peckham
June 19, 1884		Burgess, William Thomas, F.I.C., Beech-road, Reigate Hill.
Feb. 21, 1884		||Burland, Jeffrey H., care of B. R., American Bank Note Company, Ottawa, Canada
Dec. 6, 1894		Burman, G. W., 9, Ebor-terrace, Woodhouse Hill, Hunslet, Leeds.
Mar. 19, 1849	Trans.	Burnard, Charles F., Plymouth Chemical Works, Plymouth
April 15, 1886		Burnett, Edwin, E., 118, Huddleston-road, Tufnell Park, N.
June 4, 1885		Burnett, Joseph Fearon, Worcester-street, Oxford
May 4, 1893		Burnett, William Robert, Dunbeth Avenue, Coatbridge, N.B.
May 4, 1893		Burnham. John Charles, Gunpowder Factory, Kirkee, Poona, India
May 4, 1882		Burrell, B. Arthur, 5, Mount Preston, Leeds
Mar. 6, 1890		Burton, William, Clifton Junction, near Manchester
Feb. 21, 1884		Bush, Richard A., Holmdale, Baron-grove, Mitcham
Feb. 16, 1882		Bush, Baron William de, Artillery-lane, E C.
Dec. 6, 1894		Bush, William, Eastgate Villa, Chepstow-road, Newport, Mon.
Dec. 5, 1889		Butcher, W. F., 32A, Lea-terrace, Blackheath, S.E.
Dec. 4, 1890		Butcher, William J., The Grammar School, Ashburne, Derbyshire
Feb. 21, 1895		Butler, D. Butler, 41, Old Queen-street, Westminster, S.W.
Dec. 4, 1890		Butler, William Waters, The Cedars, Duchess-road, Edgbaston, Birmingham
May 3, 1894		Buttemer, Robt. Wm., St. Mary's, Godalming
June 3, 1875		Butterfield, J. C., 79, Endlesham-road, Balham, S.W.
Feb. 18, 1892		Butterfield, W. J Atkinson, Beckton, E.
Dec. 15, 1892		Buttfield, Horace Vincent, 13, Wellington-road, Bush Hill Park, Enfield, N.
Feb. 19, 1891		Byrne, Thomas, 18, Lower Kevin-street, Dublin

Date of Election.		
June 15, 1893		||Cahill, Robert S., 90, Park-lane, Norwich
Feb. 15, 1894	Proc.	Cain, John Cannell, D.Sc., Pension Anglaise, Anlage, Heidelberg
Dec. 3, 1891		||Calder, William A. S., Cawdor, Grove Park, Camberwell
June 19, 1884		Caley, Edward J., Eaton Old House, Norwich
Dec. 21, 1871		Calvert, J. H., Oakenshaw Print Works, near Accrington
Dec. 6, 1894		Cameron, Alex., Agricultural Laboratory, 4, Lombard-court, E C.
June 17, 1875		Cameron, J. Macdonald, M.P., F.G.S., F.I.C., 5, Raymond-buildings, Grays' Inn, W.C.
May 4, 1893		Cameron, James, The British Explosives Syndicate, Pitsea, Essex
Dec. 15, 1892		Campbell, Andrew, The Palens, Dunmeedaw, Rangoon, Burmah
Dec. 6, 1888		Campbell, John Morrow, B.Sc., c/o J. Morrow, Esq., Oakfield House, Anfield, Liverpool
June 7, 1888		Campbell, Rev. Joseph, Coogee, New South Wales
Mar. 20, 1884		Cannon, Matthew, Lavender Hill, S.W.
Feb. 16, 1888	Trans.	Carey, Alfred Edward, M.Inst.C.E., F.R.G.S., F.G.S., 39, Trinity-square, Tower Hill, E.C.
May 5, 1892		Carey, Arthur, B.Sc., Browside, Gateacre, near Liverpool
June 20, 1889		Cargill, William D., B.Sc., Loughaugh, near Dundee
Feb. 21, 1889		Carmody, P., Prof., F.I.C., Government Laboratory Port of Spain, Trinidad
May 6, 1875		||Carpenter, H. S., F.I.C., 32, Holborn-viaduct, E.C.; and Beckington House, Weighton-road, Anerley, S.E.
Feb. 21, 1895	Trans.	Carr, Francis H., Meaburne, Warham-road, Croydon
Nov. 17, 1887		Carrington, George Carrington, Missenden Abbey, Great Missenden, Bucks
Dec. 7, 1882		||Carruthers, Robert, 90, High-street, Dumfries
Dec. 7, 1893		Carswell, Thomas Retson, 5, Borough-road, S.E.
June 16, 1864		Carteighe, Michael, 180, New Bond-street, W.
Dec. 5, 1867		||Carulla, F. J. R., 84, Argyle-terrace, Rose Hill, Derby
Feb. 21, 1895		Case, T. B., B.A., 82, James-street, Dublin
Feb. 6, 1879		Cassal, C. E., Vestry Hall, Mount-street, Grosvenor-square, W.
Dec. 6, 1894		Catherall, Ezra, 7, Portman-terrace, Taunton
Mar. 20, 1884		||Cave, Herbert, B.A., Oxon, 11, Pelham-place, South Kensington
Mar. 5, 1874		Chaloner, George, 30, Weston-park, Crouch End, N.
Dec. 2, 1880		Chamberlain, A. G., Rugby
May 3, 1894		Chambers, Thos., Dudley House, Coatbridge, N.B.
Dec. 20, 1883		Chambres, Gordon Crewe, Rev., Head Master, Wigan Grammar School, Cheshire
Feb. 1, 1883		||Chance, Alexander M., Lawn-side, Edgbaston, Birmingham
Feb. 1, 1872		||Chandler, Charles F., Ph.D., School of Mines, Columbia College, 49th-street and 4th-avenue, New York
Feb. 1, 1872		Chandler, William H., Prof., Lehigh University, Bethlehem, Pennsylvania

Date of Election.		
Dec. 7, 1893		Chaney, Harry, J., 29, Chalcot-crescent, Regent's Park, N.W.
Feb. 21, 1884		Chantrell, Percy S.,
Feb. 21, 1889		Chaplin, Edward Mitchell, Ph.D., Westgate, Wakefield
June 17, 1886	Trans.	Chapman, Alfred C., F.I.C., The Laboratory, 23, Euston Buildings, N.W.
Jan. 16, 1868		Chapman, Edward, Hill End, Mottram, Manchester
Dec. 18, 1884		Chapman, Herbert M., The War and Sporting Smokeless Powder Company, Trimley, Suffolk
May 7, 1891		Charles, Rhys Pendrill, Plâs Newydd, Neath
Feb. 15, 1894	Trans.	Chattaway, F. D., D.Sc. London, Ph.D. Munich, B.A. Christ Church, Oxford; Chemical Laboratory, St. Bartholomew's Hospital, E.C.
Dec. 4, 1890		Cheetham, T. A., Allan Glen's School, 68, North Hanover-street, Glasgow
Dec. 5, 1878		Cheshire, H. F., Public Analysts' Laboratory, Hastings
Jan. 19, 1882		Chester, Edward D.,
Dec. 16, 1875		Cheverton, George, F.L.S., South Lawn, Tunbridge Wells
Jan. 16, 1868		Child, Gilbert W., Holywell Lodge, Oxford
Dec. 21, 1871		Childs, Christopher, M.D., Oxon, Lindisfarne, Weymouth
Dec. 3, 1891	Trans.	Chorley, John C., 23, Nassington-road, Hampstead, N.W.
June 18, 1874		Christopher, George, Walkden Works, Verney-road, South Bermondsey, S.E.
Dec. 17, 1885		Christopher, Robert G., 35, Channtler-road, Custom House, Victoria Docks, E.
Dec. 7, 1882		Chrystal, William J., 7, West George-street, Glasgow; and Shawfield Works, Rutherglen, near Glasgow
Mar. 3, 1856	Trans.	Church, Arthur Herbert, F.R.S., Shelsley, Kew, Surrey
Feb. 15, 1894		Chuni Lal Bose, Prof., 24, Mohendra Bosé Lane, Calcutta
April 19, 1888	Trans.	Claisen, Ludwig, Ph.D., Chemisches Laboratorium, Technische Hochschule, Aachen, Prussia
Dec. 15, 1892		Clark, Ernest Victor, 34, St. Aubyns, Hove, Sussex
Dec. 7, 1876	Trans.	Clark, John, Ph.D., 138, Bath-street, Glasgow
Feb. 16, 1852	Trans.	Claudet, Frederic, 6, Coleman-street, E.C.
April 15, 1886		Clayden, Arthur W., M.A., F.G.S., St. John's, Polsloe-road, Exeter
Dec. 7, 1882		Clayton, E. Godwin, F.I.C., Chemical Laboratory, 43 and 44, Holborn-viaduct, E.C.
May 4, 1893		Clayton, George, School of Pharmacy, 100, Burlington-street, Manchester
Feb. 21, 1889		Clayton, John William, Benfield, Alma-road, Aigburth, Liverpool
Dec. 4, 1873	Trans.	Cleminshaw, Edward, M.A., Alkali Works, Oldbury, near Birmingham
May 20, 1875		Clerk, Dugald, Driffield Villa, Manor Hill, Sutton Coldfield
May 19, 1856		Clift, Samuel, 63, Dudley-road, West Bromwich

Date of Election.		
Feb. 7, 1878		Cloud, Thomas Charles, A.R.S.M., Walaroo Smelting Works, Walaroo, South Australia
Mar. 18, 1869	Trans.	‖Clowes, Frank, D.Sc., University College, Nottingham
Feb. 3, 1887		Coates, William Henry, M.A., M.B., L.S.Sc., M.R.C.S., L.R.C.P., L.S.A., Bleak House, Patrington, Yorkshire
Mar. 6, 1890		Cobbold, Paul Alexander, Hailsbury viâ Mattawa, Ontario, Canada
Dec. 18, 1879		Cochran, Michael, M.A., Wiesbaden, Kollupitiya, Colombo, Ceylon
Dec. 2, 1880		‖Cockburn, Arthur Cecil, 22, Streatley-road, Brondesbury, N.
June 16, 1892		Cockerill, Thomas, 105, Derby-street, Bolton
Dec. 7, 1893		Cocking, Allan Thomas, Lyndhurst, Park-rd., Sutton Coldfield
Feb. 16, 1888		Cocking, Lewis Smith, Wharf Mills, Apsley, Huddersfield
Feb. 17, 1881		‖Coffin, Walter H., 94, Cornwall-gardens, South Kensington, and Junior Athenæum Club, S.W.
Mar. 5, 1885	Trans.	Cohen, Julius B., Yorkshire College, Leeds
Feb. 19, 1891		Cole, Arthur, B.A., Homeleigh, Berkhamsted, Herts
Feb. 19, 1891	Trans.	Colefax, Arthur, Ph.D., M.A., 4, Brick-court, Temple, E.C.
April 19, 1883		Coleman, Joseph Bernard,
Mar. 1, 1883		Collenette, Adolphus, 11, Commercial-arcade, Guernsey
Nov. 6, 1873		Collens, Edward, Stourbank House, Stourport, Worcestershire
June 16, 1881		Collett, John Marton, Guys Cliff, Wotton, Gloucester
Feb. 5, 1885	Trans.	‖Collie, J. Norman, Ph.D., University College, W.C.
Feb. 18, 1892		‖Collins, Hugh Brown, B.Sc., West Balgray, Glasgow
Feb. 6, 1890		Collins, Sydney Hoare, Dehow Dunn, North-West Province, India
Feb. 16, 1888		Collins, W. Hepworth, Analytical Laboratory, 14 and 15, Bradford-chambers, Mawdsley-street, Bolton-le-Moors
Mar. 17, 1887	Trans.	‖Colman, Harold G., Ph.D., 23, Stirling-road, Edgbaston, Birmingham
May 15, 1890		Colwell, James Kear, F.I.C., 101, Great Russell-street, W.C.
May 5, 1892		‖Comyns, Frank B. A., 55, South-street, Durham
June 18, 1891		Congdon, Prof. Ernest A., The Drexel Institute of Art, Science, and Industry, Chestnut-street, Philadelphia, Penn, U.S.A.
Feb. 18, 1875		Connor, Charles C., B.A., Notting-hill House, Malone, Belfast
April 19, 1883		‖Conrad, Edwin C., 1, Sunnyhill-terrace, Lowestoft-road, Gorleston
Feb. 15, 1877		Conroy, Michael, Woodstock, New Brighton, Cheshire
Jan. 18, 1866	Trans.	‖Conroy, Sir John, Bart., F.R.S., Balliol College, Oxford
April 4, 1889		Cook, Edward Barnwell, Rev., The Vicarage, Hinton Charterhouse, Bath
Dec. 2, 1875	Trans.	Cook, E. H., D.Sc. (Lond.), the Clifton Laboratory, 27, Berkeley-square, Clifton, Bristol
Nov. 5, 1874		Cook, Edward Rider, East London Soap Works, Bow
Dec. 4, 1890		Cooke, Arthur William,
Feb. 2, 1888		Cooke, F. Barker, F.I.C., Messrs. Bostock and Co., South Dock, Garston, near Liverpool

Date of Election.		
Nov. 15, 1888		Cooley, Walter Bromley, 5, Dudley-street, Wolverhampton
May 18, 1857		Coomber, Thomas, Rosehurst, Clarendon-road, Redland, Bristol
Jan. 17, 1889		Cooper, Albert, Grimston Lawn, Haven Green, Ealing, W.
Dec. 15, 1892		Cooper, Arthur James, Queen Elizabeth's School, Bromyard, near Worcester
Feb. 16, 1888		Cooper, Astley, Oatlands Chemical Works, Meanwood-road, Leeds
Dec. 15, 1892		Cooper, Lionel, Analytical Laboratory, 173, Marylebone-road, N.W.
May 7, 1891		Cooper, Walter Johnson, South Wales Cement Works, Penarth, near Cardiff
Dec. 6, 1894	Proc.	Coote, A. H., 8, Laurel-terrace, Bradgate-road, Catford, S.E.
April 15, 1880		Copas, Edwin Charles, M.A., The Grammar School, Handsworth, Birmingham
May 15, 1890		Copeman, Sydney Monckton, M.A., M.D. (Cantab), Local Government Board, Whitehall, S.W., and 9, Duke-st., St. James, S.W.
Feb. 19, 1891	Trans.	Corbett, Charles Henry, the Avenue, Trowbridge, Wilts
Mar. 1, 1866		‖Corfield, W. H., M.A., M.D. (Oxon), F.G.S., Professor of Hygiene and Public Health, University College, W.C., and 19, Saville-row, W.
Dec. 3, 1891		Cory, George Edward, M.A. (Cam.), the Drostdy, Grahamstown, South Africa
Dec. 6, 1888		‖Cornish, Vaughan, Branksome Cliff, Bournemouth.
April 17, 1890		Corrie, David, Nobel's Explosives Company, West Quarter Factory, Polmont Station, N.B.
Dec. 5, 1889		Coste, F. H. Perry, B.Sc., F.L.S., 142, Burnt Ash-hill, S.E.
June 15, 1893		Coste, John Henry, 20, Rectory-road, Stoke Newington, N.
June 16, 1892		Couldrey, Henry, H.M.'s Mint, Bombay, India
Dec. 17, 1885		Cousins, William J., 11 and 12, Southampton-buildings, Chancery-lane, W.C.
Dec. 16, 1886	Trans.	‖Coutts, Francis J. H., Green Mount, Plymouth-grove, Manchester
Dec. 7, 1882		‖Cowie, Thomas R., Rangoon Chemical Company, Rangoon
Feb. 6, 1873		Cownley, Alfred J., 13, Fenchurch-avenue, E.C.
April 19, 1888		Cowper, Joseph, 50, King-street, Penrith
Dec. 2, 1886		Cox, Ebenezer John, Orwell Bank, Greenwell-road, Harborne, Birmingham
Dec. 4, 1873		Cox, Samuel Herbert, 13. St. Helen's-place, London, E.C.
Dec. 1, 1870	Trans.	Crafts, Prof. J. M., 59, Marlborough-street, Boston, Mass., U.S.A.
Dec. 15, 1892		Craig, Andrew William, 77, Peel-street, North Melbourne, Victoria
June 3, 1875		‖Crampton, George, St. George's Club, Hanover-square, W.
Dec. 7, 1893		Craw, John A., Neckarhalde 52, Tübingen, Württemburg
Mar. 16, 1882		‖Crawley, H. Howard, Saugeen, Bournemouth
May 20, 1875		Cresswell, Charles Gerard, Ermyngarth, Ashtead
Mar. 3, 1887		Cribb, Cecil H., B.Sc., 136, Shaftesbury-avenue, W.

Date of Election.		
April 4, 1889		Cridland, Francis E. J., Analytical Laboratory, 192, Palmerston-buildings, Old Broad-street, E.C.
June 20, 1878		Criper, William Risdon, Cossipore Chemical Works, 3½, Hastings-street, Calcutta
May 20, 1886	Trans.	‖Crompton, Holland, Fairholme, Fulham-road, Fulham, S.W.
Dec. 3, 1857	Trans.	Crookes, William, F.R.S., 7, Kensington Park-gardens, W., and Athenæum Club, Pall Mall, S.W.
Feb. 6, 1879	Trans.	Cross, Charles Frederick, 4, New-court, Lincoln's-inn, W.C.
Dec. 4, 1890	Trans.	Crossley, Arthur W., M.Sc. (Vict.), Ph.D., Chemical Laboratory, St. Thomas's Hospital, S.E.
Feb. 21, 1895		Crossman, Tom, 40, Coldhurst-street, Oldham.
Dec. 2, 1880		Crow, John Kent, D.Sc., 23, Vanburgh-hill, Blackheath, S.E.
Dec. 1, 1887		‖Crowther, H. Woodward, Beeches-road, West Bromwich
June 19, 1884		Crumbie, William D., 146, Washington-street, East Orange, New Jersey, U.S.A.
Mar. 5, 1874		Cruse, F. V. L., Neva Stearin Works, 65, Schlusselburg-road, St. Petersburg, Russia
Mar. 17, 1887	Trans.	Cundall, J. Tudor, The Academy, Henderson-row, Edinburgh
Dec. 27, 1875		Curphey, W. S., 2, Princes-square, Strathbungo, Glasgow
Feb. 21, 1889		Curragh, John, Donaghadee, Belfast
Dec. 15, 1881		‖Custance, John D., Prof. of Agriculture, Gurnard, Cowes, Isle of Wight
Feb. 15, 1894		Dains, Herbert H., F.I.C., 3 Cantonment, Vizianagram, India
Dec. 7, 1882		Dampier, Henry L., Frinsbury-road, Strood, Kent
June 16, 1887		Daniell, L. C., Royal Standard Brewery, Tamworth, N.S.W.
April 15, 1850		‖Danson, Joseph,
Feb. 18, 1892		Darbishire, Francis V., Rossplatz 12, I., Leipzig
Nov. 15, 1852		Darby, Stephen, 140, Leadenhall-street, E.C.
Dec. 3, 1891	Trans.	Darling, Thomas, Adderstone House, Berwick-on-Tweed
May 4, 1871		Darling, William Howarth, 126, Oxford-street, Manchester
Nov. 18, 1886		Davenport, Bennett F., M.A., M.D., 161, Tremont-street, Boston, Mass., U.S.A.
Nov. 18, 1875		‖Davey, G. W., Cambridge-road, Barking, Essex
Feb. 16, 1893		Davey, George, c/o Michoacau Railway Mining Company, Maravater, Mexico
May 18, 1876		Davidson, Joseph, Holywell-green, Halifax
Feb. 1, 1866	Trans.	‖Davies, Arthur E., Ph.D., Tweedbank, West Savile-road, Edinburgh
Feb. 16, 1893		Davies, D. O. Sydney, Springwood, Uttoxeter
May 6, 1858	Trans.	Davies, Edward, The Laboratory, 28, Chapel-street, Liverpool
Feb. 16, 1882	Trans.	Davies, G. W., 8, Spring-hill, Stockport
May 5, 1892		Davies, Joseph, 28, Roberts-road, Anfield
Feb. 15, 1894		Davies, Sam. H., Battersea Polytechnic Institute, S.W.

Date of Election.		
Dec. 17, 1857		Davis, J. Frederick, F.G.S., Archbrook, Budleigh-Salterton, Devon
June 6, 1872	Trans.	Davis, Richard Hayton, 26, Regent-parade, Harrogate
Jan. 20, 1876		Davis, T. Sebastian, 199, South Lambeth-road, S.W.
Dec. 7, 1876		Davis, Walter Charles, The Manse, Prestonville-road, Brighton
June 15, 1893		Davy, S. H. M., Sharrow-view, Sharrow, Sheffield
Feb. 21, 1895		Daw, F. W., Eureka-place, Ebbw Vale, Monmouthshire
Nov. 20, 1890		Day, Charles Edwin, 145, Abbey-road, Barrow-in-Furness
Mar. 17, 1881	Trans.	Day, T. Cuthbert, 36, Hillside-crescent, Edinburgh
Oct. 11, 1894		Deane, Leo. M., South Kilworth Rectory, Rugby
Mar. 3, 1859	Trans.	Debus, Heinrich, Ph.D., F.R.S., 1 Obere Sophien-strasse, Cassel, Provinz Hessen, Germany
May 7, 1885	Trans.	Dechan, Martin, Chemical Laboratory, 5. Oliver-place. Hawick
Dec. 3, 1874		Deck, Arthur, 9, King's-parade, Cambridge
April 1, 1869	Trans.	Deering, W. H., 9, Harvey-villas, Hervey-road, Blackheath, S.E.
Dec. 15, 1881		Demarcay, Eugene Anatole, 75, Rue de Courcelles, Paris
Dec. 15, 1892		Denison, Joseph R., 1, Park-view-terrace, Manningham, Bradford
Mar. 6, 1890		Dennant, John, F.G.S., Camberwell, Victoria
Dec. 1, 1870	Proc.	Dewar, James, Prof., F.R.S., 1, Scroope-terrace, Cambridge
Mar. 4, 1886		Dey, Preo Loll, 4, Beadon-street, Calcutta
June 17, 1880		Dey, Rai Kanny Loll Bahadoor C.I.E., 4, Beadon-street, Calcutta
April 15, 1880		Dibdin, W. J., F.I.C., Mayfield, Grange-road, Sutton, Surrey
April 18, 1872		Dickenson, Arthur John, F.I.C., 4, Shadeloes-road, New Cross, S.E.
May 4, 1893		Dickinson, Henry Winram, 7, High-street, Scunthorpe, Doncaster
Dec. 1, 1887		Dickson, T. Arthur, Estate Office Overstone Park, Northampton
June 7, 1886		Diogo, Prof. A. C., Hospital Militar, 29 Rua do Evaristo da Veiga, Rio de Janeiro
Feb. 2, 1860	Trans.	Divers, Edward, Prof., M.D., F.R.S., Hongo, Tokyo, Japan
Feb. 5, 1885	Trans.	Dixon, Augustus Edward, M.D., Queen's College, Cork
June 7, 1894		Dixon, George, B.A., Trinity College, Cambridge, and St. Bees, S.O., Cumberland
Feb. 3, 1876	Trans.	Dixon, Harold B., F.R.S., Owen's College, Manchester
May 4, 1893		Dixon, Harry W., 20, Moor-crescent, Hunslet, Leeds
Dec. 18, 1862		Dixon, W. A., Technical College, 301, Pitt-street, Sydney, New South Wales
Jan. 17, 1889		Dixon, W. Hepworth, Wingfield, Wanstead, E.
April 17, 1890		Dixon, William, 4, Park-place East, Sunderland
June 15, 1882	Trans.	Dobbie, James Johnstone, M.A., D.Sc. University College, Bangor, N. Wales
Mar. 3, 1887	Trans.	Dobbin, Leonard, Ph.D., Chemical Laboratory, New University buildings, Edinburgh

Date of Election.		
Dec. 2, 1875	Trans.	Dodd, T. H., Chemical Department, Royal Arsenal, Woolwich, S.E.
April 19, 1888		‖Dodd, William Henry, 8, Kempson-road, Telbrook, Fulham, S.W.
Nov. 18, 1886		Dodd, W. Ralph, 2, St. Andrew's-pavement, Dunmore-road, Amhurst-park, N.
May 5, 1892		Dodds, George Price, 9, Day-street, Sandyford-road, Newcastle-on-Tyne
June 7, 1894	Trans.	Donald, George, Arnold Print Works, North Adams, Mass., U.S.A.
May 5, 1892		Donaldson, Hudson, The Laurels, St. Catharine's-road, Grantham
May 20, 1886		Doran, Robert Elliott, Chemical Dept. Queen's College, Cork
May 20, 1886		Dormer, Richard, Garston.
Dec. 6, 1888		Douglas, William, A.I.C., Diamond, Demerara, British Guiana
Nov. 20, 1884		Down, Frederick J., 28, Victoria-road, Old Charlton, Kent, S.E.
Feb. 3, 1887		Downes, Arthur H., M.D., Local Government Board, Whitehall, S.W.
Feb. 21, 1884		Draper, Henry Carter, Weston, Alma-road, Monkstown, co. Dublin
June 18, 1891		Dreaper, W. Porter, 15, Prince's-road, Great Yarmouth
March 4, 1886		Dresel, Adolphe, 64, Billiter-buildings, Billiter-street, E.C.
Feb. 16, 1893		Dreyfus, Charles, Ph.D., The Clayton Aniline Co., Clayton, Manchester
Dec. 4, 1890		‖Dudley, William L., Professor, Nashville, Tennessee, U.S.A.
Feb. 16, 1893	Trans.	‖Dufton, Samuel Felix, B.A., D.Sc., 6, Park-road, Red Hill, Surrey
May 5, 1892		Duffield, Walter William, 24, Ursula-street, Battersea, S.W.
Feb. 21, 1884		Duggan, T. R., Sunny-bank, Vanburgh-hill, Westcombe-park Blackheath, S.E.
Jan. 17, 1889		Duisberg, Dr. Carl, Elberfield, Germany
Dec. 5, 1889		Dukes, Thomas William, P. T. Peterson and Co., P.O. Box 210, Johannesberg, S.A.R.
June 16, 1881		Duncan, Arthur William, c/o Messrs. Woolley, Sons, & Co., Victoria Bridge, Manchester
Dec. 6, 1894		Duncan, C. C., Royal Agricultural College, Cirencester
Dec. 17, 1863		Duncan, James, 9, Mincing-lane, E.C.
Feb. 15, 1894		Duncan, Dr. John, St. Petersburg, Russia
June 18, 1891		Duncan, William, The Laboratory, 65, Bath-row, Edgbaston, Birmingham
Dec. 6, 1894		‖Dunn, Fred., 83, Packington-street, Kew, Melbourne
June 7, 1888	Proc.	Dunn, John, B.Sc., Morgan Academy, Dundee
Dec. 7, 1882		Dunn, J. T., D.Sc., Technical Schools, Plymouth
Feb. 16, 1893		Dunnington, Francis P., University of Va, Charlottesville, U.S., N.A.
Dec. 3, 1885		Dunstan, M. J. R., M.A., F.R.S.E., 9, Hamilton Drive, The Park, Nottingham

Date of Election.		
Dec. 18, 1879	Trans.	Dunstan, Wyndham, Prof., M.A., F.R.S., 17, Bloomsbury-square, W.C.
Jan. 19, 1860	Trans.	Dupré, August, Ph.D., F.R.S., Westminster Hospital Medical School, Caxton-street, Westminster, S.W.
Feb. 16, 1860		Dupré, Frederick, Ph.D., Stassfurt, near Magdeburg, Germany
June 1, 1871		||Durham, Henry, City of London School, Victoria Embankment, E.C.
Dec. 6, 1883		Durrant, Reginald G., B.A., The College, Marlborough, Wilts
Dec. 6, 1894		Dutson, L. B., 14, Vicarage-place, Walsall
Dec. 6, 1883		Dutta, Ramchandra, Medical College, Calcutta
Dec. 15, 1892		Duxbury, Thomas, The Corporation Gas Works, Darwen
Dec. 16, 1875	Trans.	||Dyer, Bernard, D.Sc. (Lond.), 17, Great Tower-street, E.C.
Feb. 6, 1890	Trans.	Dymond, Thomas Southall, 78, Duke-street, Chelmsford
Nov. 19, 1885		Dyson, Gibson, Ph.D., Temple House, Cheetham Hill-road, Manchester
Mar. 1, 1883	Trans.	Dyson, Septimus, 2, Exchange-place, Middlesbrough

Dec. 7, 1882		Earl, Alfred George, M.A., Ferox Hall, Tonbridge
Feb. 1, 1876		Earp, Francis S., Ph.D., c/o Major Earp, Claverdon, near Warwick
April 4, 1889	Trans.	Easterfield, Thomas Hill, M.A., Ph.D., 122, Tenison-road, Cambridge
Dec. 3, 1891		Eastick, Charles E., Grove-terrace, Grove-road, Leytonstone
Feb. 1, 1881		Eastick, John J., Millaquin Refinery, Bundaberg, Queensland
Dec. 5, 1878	Trans.	||Eccles, Herbert, Briton Ferry, Glamorgan
Mar. 17, 1881		Edgell, R. Arnold, Rev., M.A., The College House, Leamington
June 1, 1876		Edmunds, James, M.D., 29, Dover-street, Piccadilly, W.
June 22, 1888		Edmunds, Lewis, Barrister-at-Law, 1, Garden-court, Temple, E.C., and 60, Park-street, Park-lane, W.
Feb. 7, 1848	Trans.	||Edwards, John B., Ph.D., Montreal
May 4, 1893		Edwards, Thomas, Brewery House, Rhymney, viâ Cardiff
Feb. 21, 1884		Edwards, Vincent, Lawes' Chemical Manure Co., Barking Creek, Essex
May 5, 1892		Edwards, Walter N., 4, Herne Hill-road, Camberwell, S.E.
June 16, 1887		||Ehrhardt, Ernest Francis, D.Sc., Ph.D., A.M.C. Anilinfabrik, Ludwigshafen-am-Rhein
Nov. 20, 1884		Ehrmann, Leon, The Mauritius Engrais Chemiques Co., Port Louis, Mauritius
Dec. 1, 1864	Trans.	Ekin, Charles, 143, New Bond-street, W.
Dec. 20, 1883		Ekins, Arthur E., County Laboratory, St. Albans
Nov. 17, 1887		Elborne, William, B.A. (Cantab.), 35, Abbey-gardens, St. John's Wood, N.W.
Dec. 3, 1891	Trans.	Elford, Percy, St. John's College, Oxford
Feb. 7, 1878		Elliott, Arthur H., Ph.D., c/o Consolidated Gas Co., 4, Irving-place, New York City, U.S.A.

Date of Election.		
Dec. 7, 1893		Ellis, Charles S., A.I.C., 95, Hyde-road, West Gorton, Manchester
April 17, 1890		Ellis, Thomas Flower, Widmore, Bromley, Kent
Feb. 7, 1878		Ellis, W. H., School of Practical Science, Toronto, Ontario, Canada
May 5, 1892		Ellison, Henry, junr., Whitechapel-road, Cleckheaton
Mar. 15, 1888		Ellwood, Thomas Ashcroft, 110, Rosebery-avenue, E.C.
Feb. 16, 1893		Elmore, Alexander Stanley, Oulton-green, Oulton, Yorks.
Mar. 4 1886	Trans.	Elworthy, Herbert Samuel, 4, Hill-road, Paudra, Bombay, India
Feb. 5, 1885		Embrey, George, Oriel Lodge, Tuffleigh, near Gloucester
Feb. 3, 1887		||Emmons, Hamilton, c/o N. H. Emmons, Esq., 40, Water-street, Boston, Mass, U.S.A.
June 16, 1892		Entwistle, Herbert, Fairholm, Marsland-road, Sale
Dec. 3, 1885		Epps, James, junr., Norfolk House, Beulah Hill, Upper Norwood, S.E.
Dec. 5, 1889		Erskine, J. Kerr, c/o George Goch, G.M. Co., Box 540, Johannesberg, S.A.R.
June 21, 1883	Trans.	Esilman, Alexander, Fleetwood Lodge, 25, Roe-lane, Southport
May 1, 1862		||Esson, William, F.R.S., Merton College, Oxford
Feb. 2, 1865		||Estcourt, Charles, St. Andrew's-chambers, 20, Albert-square, Manchester
Feb. 2, 1888		||Estcourt, Philip Anderson, Chemical Laboratory, 20, Albert-square, Manchester, and Vyrmew House, Talbot-road, Old Trafford, Manchester
June 7, 1894		Eumorfopoulos, Nicholas, 1, Kensington Park-gardens, W.
Mar. 17, 1887		Evans, Alfred J., M.A., B.Sc.,
May 7, 1891		Evans, Frederick Arthur, The Cape Copper Co., Ookiep, Namaqualand, Cape of Good Hope
June 15, 1876		Evans, Gwilym, 7, Stepney-street, Llanelly, South Wales
May 4, 1893		||Evans, Robert Cecil Turle, 6, Gower-street, W.C.
June 16, 1892		Evans, Sir John, K.C.B., F.R.S., Nash Mills, Hemel Hempstead
Dec. 6, 1888		||Everard, Arthur George, 27, Northcote-road, Clapham Junction, S.W.
Feb. 15, 1894		Evershed, Frank, Kenley, Surrey
Feb. 17, 1876		Faber, H. M., Rev., 1, College-grounds, Malvern
Mar. 15, 1888		Faber, Harald N., Fiona, Lennard-road, Penge, S.E.
May 18, 1865	Trans.	||Fairley, Thomas, F.R.S.E., 8, Newton-grove, Leeds, and 16, East-parade
Nov. 15, 1888		Farlie, John B., 6, Ripon-villas, Ripon-road, Plumstead, S.E.
Feb. 21, 1895		Fairrie, Henry, 63, Parkfield-road, Liverpool
Dec. 1, 1870		Farries, Thomas, 16, Coleman-street, E.C.
Dec. 2, 1880		||Farrington, Thomas, M.A., 4, Waterloo-place, Cork

Date of Election.		
Feb. 15, 1894		Fawcett, Joseph Addey, 54, Broxholme-road, Doncaster
Dec. 1, 1887		Fawsitt, Charles A., 9, Foremount-terrace, Dowanhill, Glasgow
May 17, 1888		Fell, John Campbell, 188, Stanhope-street, Regent's-park, N.W.
Dec. 5, 1878	Trans.	Fenton, H. J. H., M.A., Christ College, Cambridge, and 7, Mortimer-road, Cambridge
June 20, 1872		‖Ferguson, John, Prof., M.A., University of Glasgow
Feb. 4, 1864		‖Ferreira, A. A., M.P.S., Rio de Janeiro, Brazil
Feb. 21, 1889		Ferrier, David, Edin-terrace, Perth
Nov. 16, 1882		Ferrier, James, care of Dr. David Ferrier, F.R.S., 34, Cavendish-square, W.
Dec. 4, 1873		Field, Charles L., Upper Marsh, Lambeth, S.E.
May 15, 1890		Findlay, George H., The Brewery, Boro' Bridge, Yorks
Mar. 7, 1872	Trans.	‖Fisher, Walter William, M.A., 5, St. Margaret's-road, Oxford
April 3, 1873		Fison, Edward Herbert, Stoke House, Ipswich
April 18, 1872		Fison, Frederick William, M.A., 98, Cromwell-road, S.W.
Feb. 15, 1894		FitzGerald, Rev., Henry Purefoy, B.A., Wellington College, Berks
Dec. 19, 1867		Fletcher, A. E., F.I.C., Delmore, Caterham Valley, Surrey
April 16, 1874		Fletcher, Frederick W., North London Chemical Works, Holloway, N., and Beauchamp Lodge, Enfield
Dec. 3, 1885		‖Fletcher, Lazarus, M.A., F.R.S., 36, Woodville-road, Ealing London, W.
April 18, 1872	Trans.	‖Fletcher, Thomas William, Grappenhall, Warrington
June 7, 1894		‖Flintoff, Robert J. Huxby, Crumpsall-lane, Crumpsall, Manchester
Feb. 18, 1892		Floris, Robert Brooke, Grandtully, Shrewsbury-road, Stonebridge Park, Willesden, N.W.
Dec. 6, 1894		Fogg, C. A., 48, Kent-street, Bolton
June 16, 1859		Fogg, Thomas, 6, Clarendon-gardens, Maida-vale, W.
Dec. 5, 1889		Foggie, John, University College, Dundee
May 7, 1885		Follows, Harold, 39, Meadow-street, Moss-side, Manchester
Feb. 21, 1853		Foord, George, Royal Mint, Melbourne, Australia
Dec. 6, 1894		‖Forbes, D. G., Shillingstone, Dorset
Nov. 19, 1874		Forbes, James, jun., 70, Gracechurch-street
Dec. 5, 1889		Ford, John S., care of Messrs. W. Younger and Co., Abbey Brewery, Edinburgh
Mar. 4, 1886		Formoy, James Arthur, Lestelle, London-road, Forest Hill, S.E.
Dec. 7, 1893		Forrester, Alexander M., Laboratory, Port Dundas Chemical Works, 20, Canal-bank, Glasgow
Dec. 15, 1892	Trans.	‖Forster, Dr. Martin Onslow, 48, Wandsworth Bridge-road, Fulham, S.W.
Mar. 3, 1856		Forsyth, W. Cay, St. Andrew, Queen's-road, Leytonstone
Feb. 2, 1888	Trans.	‖Foster, G. C., F.R.S., 18, Daleham-gardens, Hampstead, N.W.
May 7, 1891		Foster, John Alfred, The Laboratory, H.M.'s Dockyard, Portsmouth

Date of Election.		
April 6, 1865		Foster, Dr. M., F.R.S., Trinity College, Cambridge
April 4, 1872		Foster, Reginald Le Neve, The Firs, North-road, Droylsden near Manchester
May 7, 1891		‖Fowler, Gilbert J., Dalton Hall, Victoria Park, Manchester
Mar. 16, 1882		Fowler, William, 1, Grace-terrace, Sunderland
June 19, 1884		‖Foye, Martin Hugh, M.B., C.M.,
June 21, 1877		Franchimont, A. E. N., Ph.D., Leiden, Holland
Dec. 18, 1879		Francis, Edward, Ivey Bank, Park Valley, Nottingham
Nov. 6, 1873		‖Francis, G. Bult, 38, Southwark-street, S.E.
Nov. 7, 1842	Trans.	Francis, William, Ph.D., F.L.S., Manor-house, Richmond, Surrey, and Red Lion-court, Fleet-street, E.C.
Dec. 20, 1847	Trans.	‖Frankland, E., D.C.L., F.R.S., The Yews, Reigate-hill, Reigate
June 16, 1881		Frankland, Henry, Streonshalk, The Crescent, Linthorpe, Middlesbro'
Dec. 2, 1880	Trans.	‖Frankland, Percy Faraday, Ph.D., F.R.S., Mason College, Birmingham
Mar. 21, 1867		‖Fraser, Dr. Angus, 232, Union-street, Aberdeen
May 5, 1892		‖Fraser, James C., Victoria-square, Adelaide, South Australia
May 7, 1885		Freear, Harry M., Hedgefield, Harpenden, Herts
June 16, 1887		Freeman, Frederick W., 7, Park Hall-place, East Finchley
Mar. 7, 1867		Freeman, J. Hersee, Stratford House, Stratford, E.
April 4, 1889		Freestone, Joseph T., 1, Kerfield-terrace, New Ferry, Cheshire
Dec. 15, 1892		French, William, Highfield, 135, Walmersley-road, Bury, Lancs.
April 4, 1889	Trans.	Frew, William, King James'-place, Perth
Feb. 2, 1871	Trans.	‖Friswell, R. J., 115, Darenth-road, Stamford Hill, N.
Dec. 18, 1884		Frost, Joe, Moldgreen, Huddersfield
Nov. 20, 1890		‖Frost, Robert,
April 15, 1880		Fryer, Alfred Cooper, Ph.D., M.A., 13, Eaton-crescent, Clifton, Bristol
Dec. 3, 1891		Fulcher, Lionel William, B.Sc., South Kensington Museum, S.W.
Feb. 16, 1893		Fuller, Frederick George, 19, Brunswick-square, W.C.
Dec. 2, 1886		Fuller, John, Rookwood, Chapter-road, Willesden Park, N.W.
Mar. 1, 1883		Fulton, H. B., 33, St. Dunstan's-road, West Kensington, W.
May 3, 1894		Gabb, George Hugh, 91, Elgin-avenue, Maida Vale, W.
Feb. 18, 1892		Gailleton, Alfred T., Tulloch House, Perth, N.B.
April 19, 1866		Gale, James, Ph.D., M.A., F.G.S., Galeston, Eton-avenue, South Hampstead
Dec. 20, 1847	Trans.	Galloway, Robert, 60, Pembridge-villas, Bayswater
Mar. 4, 1875		‖Galton, Douglas, Sir, K.C.B., F.R.S., 12, Chester-street, Grosvenor-place, W., and Himbleton Manor, Droitwich

Date of Election.		
Mar. 17, 1851		||Gamble, David, Colonel, C.B., St. Helens, Lancashire
April 6, 1876		Gamble, J. C., St. Helens, Lancashire
Dec. 6, 1883	Proc.	||Garbutt, Llewellyn. M.D., The College, Winchester
Mar. 15, 1888		Gardiner, James H., 59, Wroughton-road, Balham, S.W.
Feb. 21, 1895		Gardner, H. Edward, Agricultural College, Aspatria, Cumberland
May 4, 1893	Trans.	Gardner, J. Addyman, Chemical Department, Museum, Oxford
June 21, 1877		Gardner, John, 3, Hanover-street, Hanover-square, W.
Nov. 15, 1888		Gardner, Walter M., The Yorkshire College, and Manor Cottage, Richmond-road, Headingley
May 5, 1892		Gargari, Haridas, M.A., Agra College, Agra, India
Dec. 7, 1893	Trans.	Garnett, Henry, 2, Bartholomew Villas, Kentish Town, N.W.
Jan. 17, 1889		Garrett, Frederic Chas., B.Sc., The Polytechnic, Woolwich, S.E.
Jan. 20, 1876		||Gaskell, Ernest Holbrook, 5, The Grove, Highgate, N.
April 17, 1884		Gaskell, Joseph, 1, Woodlands-road, Cheetham-hill, Manchester
Jan. 18, 1847		Gatty, F. A., Holland Bank, Accrington, Lancashire
Nov. 4, 1875		Gee, T. Ernest, F.R.C.P., 67, Westbourne-park-road, W.
Mar. 3, 1887		Geisler, Joseph F., Ph.C., Mercantile Exchange Buildings, Hudson and Harrison-streets, New York
May 7, 1885		Gemmell, George Harrison, 4, Lindsay-place, Edinburgh
April 17, 1879		Gent, William Thomas, Misterton, Gainsborough
Feb. 21, 1889		||Gerland, Conrad, M.Sc., Ph.D., Municipal Technical Laboratory, Blackburn; and Accrington
Dec. 3, 1891		German, George, Junr., Huntingdon House, Ashby-de-la-Zouch
Feb. 21, 1895		|Gerrans, H. Tresawna, M.A., 20, St. John-street, Oxford
Nov. 4, 1875		Gerrard, A. W., Chertsey
Dec. 6, 1888		Geyzel, John Lawrence Van, Surgeon-Major, Chemical Examiner, Madras, East India
June 7, 1894		Ghasvala, B. E., Grant Medical College, Byculla, Bombay
Feb. 6, 1890		|Gibbes, Cuthbert C., M.D., M.C., L.R.C.P. Lond., D.P.H. Cantab., F.G.S., F.L.S., Roselands, Surbiton Hill, S.W.
May 7, 1891		Gibbins, Bevington H. Ocata, Florida, U.S.A., and Inglescombe, Manor Park, Redland-road, Bristol
Feb. 18, 1864		Gibbons, Sydney, Faraday House, East Melbourne, Victoria
May 16, 1889		Gibbs, William Taylor, Buckingham, Que, Canada, viâ New York
Mar. 5, 1885		Gibson, Adam, c/o Messrs. Pinkerton, Gibson & Co., Thistle-street-lane, East Edinburgh
June 16, 1892	Trans.	Gibson, John, Ph.D., F.R.S.E., F.I.C., 20, George-square, Edinburgh
June 21, 1888		Gibson, W. Humphrey, 122, King's-road, Brighton
May 18, 1841	Trans.	Gilbert, Sir Joseph Henry, Ph.D., F.R.S., F.L.S., Harpenden, St. Albans
Feb. 1, 1883		||Gill, E. Clarendon, Ivy Dene, Christchurch, Hants
Mar. 17 1881		Gill, E. J. G., Wellikuppam, Madras Presidency, India

Date of Election.		
April 19, 1888		Gill, John, Gwealhellis, Helston, Cornwall
April 6, 1865		||Gillman, A. W., Castle Brewery, St. George's-road, Southwark
Dec. 3, 1885		Girdwood, Gilbert P., M.D., 54, Beaver Hall Hill, Montreal, Canada
Dec. 18, 1848	Trans.	Gladstone, John Hall, Ph.D., F.R.S., 17, Pembridge-square, Hyde Park, W.
Mar. 4, 1886		Glenfield, Francis W. S., 27, Gloucester-gardens, Hyde Park-square, W.
Jan. 18, 1872		Glover, George Thomas, The Phospho-Guano Company, Seacombe, Cheshire
May 3, 1894		Golden, Arthur Robert, B.A.
Feb. 21, 1895		Goldfinch, George, Hendon, N.W.
April 4, 1878		Goldschmidt, S. A., Ph.D., care of Columbia Chemical Works, 43 to 51, Sedgwick-street, Brooklyn, New York
May 16, 1889		Goldsmith, Byron B., 19, East 74th-street, New York City, U.S.A.
Dec. 15, 1892		Goodall, Walter, Alma House, Pudsey, near Leeds
Dec. 4, 1890		Goodwin, Thomas S., Clyde-terrace, Tollcross, Glasgow
Nov. 20, 1890		Gordon, Colin, Storer's Wharf, Cubitt Town, E.
April 21, 1887	Proc.	Gordon, Hugh, M.A. Oxon., 3, Courtfield-gardens, S.W.
Mar. 4, 1875		Gordon, J. G., Queen Anne's Mansions, Westminster, S.W.
Mar. 6, 1890		Gossling, Frank, B.Sc., Condebec, Park Side, Hampton Wick
Feb. 1, 1883		Gothard, Frederic, Bearwood House, Burton-on-Trent
Jan. 17, 1889		||Gott, B. S., B.A., Corinium, St. Mark's, Cheltenham
Feb. 6, 1879		Gough, Thomas, Rev., B.Sc. (Lond.), King Edward's School, Retford, Notts
June 16, 1887		Gover, Herbert J., 29, Piccadilly, Hanley, Staffordshire
Jan. 17, 1889		Gow, Robert J., The Cedars, Hough Green, near Widnes
May 4, 1893		Gower, Alfred Roland, 18, West View-road, Barrow-in-Furness
Feb. 2, 1871	Trans.	||Gowland, William, 19, Beaumont-crescent, West Kensington
Feb. 3, 1887	Trans.	Goyder, George A., Hawkins-road, Medindie, Adelaide, South Australia
June 19, 1884		Grace, W. F., 54, York-road, Hove, Brighton
Feb. 15, 1894		Grafton, Walter, 11, Grosvenor-road, Upton Park, Essex
April 15, 1880	Trans.	||Graham, C. Colborne, care of Messrs. Blundell, Spence, and Co., Beverley-road, Hull
May 1, 1862	Trans.	||Graham, Charles, D.Sc., 23, Euston-buildings, Gower-street Station, N.W.
Feb. 6, 1890		Grant, James, 9, Arthur-street, Prestwich, near Manchester
June 16, 1887		Gravill, Edward D., F.R.M.S., 44, Margaret-street, Beverley-road Hull
Dec. 7, 1882		Gray, George, Canterbury College, School of Agriculture, Lincoln, New Zealand
Dec. 15, 1892		Gray, Thomas, Andersonian-buildings, 204, George-street, Glasgow

Date of Election.		
Feb. 19, 1891		Greaves, Robert Bond, 77, Netheredge road, Sheffield
Dec. 4, 1890		Green, Alfred H., Oaklands, Lowton St. Mary's, Newton-le-Willows
Feb. 5, 1885	Trans.	||Green, Arthur George, 13, King's-drive, Heaton Moor, near Stockport
June 15, 1893		Green, Arthur Henry, 176, Lloyd-street, Greenheys, Manchester
June 16, 1887		Green, John Edward, F.I.C., A.R.S.M., 52, Claypath, Durham
Dec. 5, 1878		Green, Herbert, Hayle Mill, Maidstone
Dec. 5, 1878		Green, Lawrence, Lower Tovil, Maidstone
April 2, 1874	Trans.	Greenaway, Alfred John, F.I.C., 39, Frognal, Hampstead, N.W.
Dec. 3, 1885		Greene, William H., M.D., 204, North 36th-street, Philadelphia
May 18, 1871		Greenish, Thomas, F.R.M.S., 20, New-street, Dorset-square, N.W.
June 4, 1885		Greenway, Thomas J., 8th Avenue, East Adelaide, South Australia
May 15, 1873		Greenwood, William Henry, Birmingham Small Arms and Metal Co., Adderley Park Works, 21, Portland-road, Birmingham
Dec. 6, 1894		Greeves, Alf., Southlands College, Battersea, S.W.
June 18, 1891		Gregory, Alfred John, M.D., B.Sc., Colonial Secretary's Office, Cape Town
May 7, 1885		Gregory, G. M., Ghazipur, N.W.P., India
Mar. 1, 1883		||Grenfell, Claud, M.A., c/o Miss Boole, 16, Ladbroke-road, W.
Mar. 5, 1874		Greville, Henry Leicester, Diersheim, Churchfields, Woodford
Dec. 7, 1893		Grieve, William Hatten, 226, Friern-road, East Dulwich, S.E.
Feb. 2, 1888		Griffith, D. Agnew, Ballaspet, St. Johns, Isle of Man
June 16, 1859		Griffith, George, M.A., College-road, Harrow
Dec. 15, 1881	Trans.	Griffiths, Arthur Bower, Ph.D., F.R.S.E., 12, Knowle-road Brixton, S.E.
April 17, 1879		Griffiths, Thomas, The Cedars, Clapham Common, S.W.
Feb. 21, 1895		Grime, Herbert, 11, Church-rd., Chorlton-cum-Hardy, Manchester,
Feb. 19, 1874	Trans.	||Grimshaw, Harry, Gibbons-street Chemical Works, Bradford, Manchester
April 15, 1880		Grimwood, Robert, London County Council, Chemical and Gas Department, 40, Craven-street, W.C.
May 4, 1893		Grimwood, Robert George, 41, Lady Margaret-road, St. John's College Park, N.W.
Dec. 5, 1889		Gripper, Harold, 2, Heald-place, Rusholme, Manchester
Dec. 15, 1892		Gronow, William Thomas, Port Pirie Smelting Works, Port Pirie, South Australia
April 6, 1871	Trans.	||Groves, Charles Edward, F.R.S., Kennington-green, S.E., and Guy's Hospital, S.E.
Dec. 17, 1857		Groves, T. B., Belmont, Seldown, Poole
April 20, 1871		Grundy, Cuthbert Cartwright, F.L.S., Homefield, Lytham-road, Blackpool

Date of Election.		
Jan. 17, 1889		Gudeman, Edward, Ph.D., P.O. Box 3001, New York City, U.S.A.
June 7, 1888		Guiterman, Albert L., Ph.D., 36, Primrose Hill-road, N.W.
Dec. 6, 1888		Guthrie, Frederick Bickell, Chemical Laboratory, The University, New South Wales
Nov. 4, 1875		Guyer, James Brett, Wrentham, Higher Erith-road, Torquay
June 4, 1874		Habirshaw, W. M., 159, Front-street, and 315, Madison-avenue, New York City, U.S.A.
Feb. 7, 1878		‖Hadkinson, John
June 7, 1894		Hadley, Arthur, 226, Monument-road, Edgbaston, Birmingham
Dec. 7, 1893		‖Hadley, Henry Edwin, The School of Science, Kidderminster
Dec. 16, 1886	Trans.	Haga, T., No. 1, Sadowara-Cho, Tokyo, Japan
June 16, 1881		Hailes, Alfred James de, 15, Red Lion-square
Dec. 15, 1892		Haines, Walter S., Prof., c/o Rush Med. College, Chicago, U.S.A.
Jan. 20, 1876	Trans.	Hake, H. Wilson, Ph.D., Westminster Hospital, S.W.
Dec. 7, 1893		Hale, Henry Ormsby, Oundle School, Northamptonshire
Dec. 3, 1891		Hall, A. D., 36, Poplar-grove, West Kensington Park, W.
Jan. 17, 1889		Hall, Allan T., Ivy Cottage, Willerby, near Hull
Dec. 3, 1891		Hall, Archibald, 34, Bishopsgate-street, E.C.
April 4, 1889		Hall, James, B.A., B.Sc., Bancroft's School, Woodford, Essex
Dec. 1, 1887		Hall, J. C. August, c/o J. C. Hall, Esq., Poste Restante, Box 172, Durban, Natal, South Africa
Jan. 17, 1889	Trans.	Hall, John A., Victoria Chemical Works, Victoria, B.C.
May 3, 1866		‖Hall, Marshall, Capt., Easterton Lodge, Parkstone, R.S.O., Dorset
June 1, 1876		Hall, Samuel, East London Soap Works, Bow
Dec. 18, 1884		Hall, Thomas P., M.A., Ph.D., Tabor, Iowa, U.S.A.
Feb. 16, 1893		Haller, Albin, 14, Rue de Metz, Nancy, France
May 20, 1886		Halliburton, William Dobinson, M.D. Lond., B.Sc. Lond., F.R.S., 9, Ridgmount-gardens, Gower-street, W.C.
Feb. 3, 1859		‖Hambly, C. H. Burbidge, Holmeside, Hazelwood, near Derby
April 17, 1890	Trans.	Hambly, Frederick J., University College, Dundee
June 7, 1888		Hamilton, James C., Trinity Lodge, Edinburgh
Feb. 15, 1894		Hamilton, Robert, Leeds Steel Works, Leeds
May 6, 1875	Trans.	Hamlet, W. M., Government Laboratory, Macquarie-street, Sydney, N.S.W.
Dec. 7, 1882		Hammersley, W. A. Leslie, Bridge House, Leek, Staff.
Jan. 18, 1877		Hampton, William, 38, Lichfield-street, Hanley
Feb. 7, 1857		Hanbury, Cornelius, Plough-court, Lombard-street, E.C., and Dynevor House, Richmond, Surrey
June 15, 1893		Hancock, Ernest Albert, Government Laboratory, St. Kitts, Leeward Islands, W.I.
Mar. 7, 1872	Trans.	Hannay, James Ballantine, Whitehall Club, S.W.

Date of Election.		
Feb. 21, 1889		‖Hanson, Alfred Miall, The Marjorie, Whalley, near Blackburn
Feb. 21, 1895		Hanson, Weldon, 30, Baker-street, Middlesbrough
Feb. 3, 1859	Trans.	‖Harcourt, A. G. Vernon, M.A., D.C.L., LL.D., F.R S., Cowley Grange, Oxford
April 16, 1863		‖Harcourt, L. F. Vernon, M.A., Fairholme, Weybridge
Mar. 17, 1887	Proc.	‖Harden, Arthur, Ashville, Upper Chorlton-road, Manchester
May 7, 1885		Hards, William Benjamin, B.A. Lond., St. John's College, Battersea, S.W.
Dec. 15, 1892		Hardy, James G., 1, Keir-terrace, Pollokshields, Glasgow
Jan. 20, 1876		Hargreaves, James, Peel House-lane, Farnworth, near Widnes, Lancashire
June 19, 1884		Hargreaves, John, Widnes, Lancashire
Dec. 16, 1875		Harkness, William, Laboratory, Somerset-house, W.C.
June 1, 1876		Harland, R. H., 37, Lombard-street, E.C.
Feb. 7, 1878		‖Harland, William Dugdale, 48, King-street, Manchester
Mar. 2, 1857		‖Harley, George, M.D., F.R.S., 25, Harley-street, Cavendish-square, W.
Jan. 15, 1874		‖Harman, Frederick Edwin, M.R.A.C., care of Dr. Piggott, Orchard-gardens, Teignmouth, Devon
Dec. 15, 1881		Harrington, William Bury, Leeview, Montenotte, Cork
Feb. 21, 1884		Harris, Frank W., Laboratory, G.W. Ry., Swindon, Wilts
Dec. 7, 1893		Harris, Harold, Bengal Iron and Steel Co., Barrakuro, Bengal
Feb. 21, 1895		Harris, Harry, Pulo Brani Smelting Works, Singapore
Dec. 17, 1874		Harris, Henry Penley, 15, Coverdale-road, Shepherd's Bush, W.
Dec. 2, 1886		Harris, Sydney Joseph, Leeds School of Science and Technology, Rossington-street, Leeds
June 7, 1894		Harris, Sydney Walters, 15, Lansdowne-terrace, Walters-road, Swansea
Feb. 7, 1878		‖Harris, Thomas Frederick, B.Sc., Bromley Lodge, Bromley, Kent
Feb. 21, 1895		Harris, Walter, B.A., Ph.D., Campbell College, Belfast
May 17, 1888		Harrison, Albert, 72, Windsor-road, Forest Gate
Feb. 15, 1894	Trans.	Harrison, Edward Frank, 40, Lovaine-place, Newcastle
June 21, 1883		‖Harrison, Hugh Erat, B.Sc., Leigh Chambers, Gt. Ormond-street, W.C., and Faraday House, Charing Cross-road
May 17, 1888		Harrison, J. Burchmere, Government Laboratory, British Guiana
Feb. 19, 1891		Harrold, Frederick W., 18, Maddox-street, W.
Feb. 17, 1876	Trans.	Harrow, G. H., Ph.D., 127, Station-street, Burton-on-Trent
Mar. 4, 1886		Hart, Bertram Harvey, The Elms, Old Charlton, Kent, S.E.
Jan. 21, 1869	Trans.	Hart, F. W., Esq., Holly House, 96, Stoke Newington-road, N.
Mar. 15, 1888		Hart, James, 131, Embden-street, Manchester
Dec. 6, 1883		Hart, Thomas, 166, Blackburn-road, Bolton
May 7, 1891		Hart, William Beaumont, Gransmoor Avenue, Fairfield, near Manchester
Mar. 16, 1882		Hartley, Arthur, Cannon Brewery, Brighton

Date of Election.		
Dec. 20, 1866	Trans.	Hartley, Walter Noel, Prof., F.R.S., Royal College of Science, Stephen's-green, Dublin ; and 36, Waterloo-road, Dublin
Feb. 6, 1890	Proc.	Hartog, P. J., B.Sc., Owens College, Manchester, and 6, Greville-road, London, N.W.
Dec. 3, 1885		Harvey, Ernest Wm., A.R.S.M., 39, Alderbrook-rd., Balham, S.W
Feb. 17, 1881		Harvey, Sidney, Canterbury
Feb. 15, 1894		Harvey, W. Pellew, Assay and Mining Office, Vancouver, B.C.
May 6, 1875		Hastings, Henry Mitchell, 54, Edith-road, The Cedars, West Kensington
Feb. 21, 1894		Hatfield, J. Adams, 2, Margaretta-terrace, Oakley-st., Chelsea
Feb. 18, 1892		Hatton, William Percy, care of W. R. Hatton and Sons, Wormwood Scrubs
Dec. 2, 1880		Hawkes, Alfred E., M.D. Bruss., L.R.C.P. Edin., 22, Abercromby-square, Liverpool
Feb. 2, 1888	Trans.	Hawkins, Lewis Walter. 20 Norton Folgate, London, E.
Dec. 6, 1894		Haworth, E., B.Sc., Hyndburn-bridge, Clayton-le-Moors, Accrington
Mar. 3, 1887		Hay, Alexander, 97, Higher Ardwick, Manchester
April 15, 1880		Haydon, William Frederick, The Exchange, Birmingham
Feb. 15, 1894		Hayward, Edward Stanley, c/o Mrs. Sauders, 109, High-street, Crediton, Devon
Dec. 1, 1887		Head, C. James, F.I.C., c/o C. Preston, 8, Trinity-square, Brixton, S.W.
Dec. 15, 1881		Head, Harold Ellershaw, 5, Ilchester-mansions, Kensington, W.
Mar. 16, 1876		Head, Jeremiah, 47, Victoria-street. Westminster, S.W.
June 21, 1883		Heap, Hargreaves, Rev., B.Sc., The Grammar School, Rotherham, Yorks
Feb. 16, 1893		Heath, Arthur John, 1, Grove-villas, Redland, Bristol
Dec. 3, 1891		Heath, John William, 33, Upper Gloucester-place, W.
Mar. 3, 1887		Hedley, T. Albert, 41, Jean Baptiste-street, Montreal, Canada
Nov. 2, 1876		Hehner, Otto, 11, Billiter-square, E.C.
Dec. 5, 1889		Helbing, H. B., 63, Queen Victoria-street, E.C.
Dec. 4, 1890		Heller, William M., B.Sc., 40, Gauden-road, Clapham, S.W.
June 3, 1875		‖Hellon, Robert, Ph.D., Seascale, viâ Carnforth
Jan. 18, 1872		Helm, Henry James, Simonstone, Hammelton-road, Bromley, Kent
Dec. 6, 1894		Helms, Albert, 8, Bridge-street, Sydney, N.S.W.
Feb. 5, 1885	Trans.	Henderson, George G., Prof., M.A., D.Sc., F.I.C., the Technical College, 204, George-street, Glasgow
Feb. 18, 1892		Hendrick, James, Young Laboratory, 60, John-street, Glasgow
April 19, 1883		Henning, E. C., Anchor Brewery, Dublin
Feb. 21, 1853		Hepburn, J. G., LL.B., Dartford, Kent
June 18, 1885		Hepworth, Thomas Cradock, 45, St. Augustine's-road, Camden-square, N.W.

Date of Election.		
Feb. 16, 1871		Herman, Douglas, Eccleston-park, Prescot
June 15, 1876	Trans.	Heron, John, 74, North Side, Clapham Common, S.W.
Dec. 7, 1893		Hesketh, William, 16, New Market-street, Blackburn
May 5, 1892	Trans.	Hewitt, John Theodore, People's Palace Technical Schools, E.
Feb. 18, 1892		Hewlett, John C., 40, Charlotte-street, Great Eastern-street, London, E.C.
June 21, 1883	Trans.	Heycock, Charles T., M.A., 24, Fitzwilliam-street, Cambridge
Feb. 16, 1882		Heyes, J. F., Rev., M.A. Oxon., F.R.G.S., Crowell, Chinnor, Tetsworth, Oxon
April 1, 1875		Heywood, Charles A., Ivy Bank, Cardiff
Dec. 1, 1864		Heywood, Henry, Cardiff
Dec. 1, 1887		Heywood, J. Garnett, 127, Sutherland-avenue, Maida Vale, W.
Feb. 6, 1890		Heywood, Joseph H., Sparth Cottage, Manchester-road, Rochdale
April 3, 1848		Heywood, J. S. C., 19, Inverness-terrace, Kensington-gardens, W.
June 1, 1876	Trans.	Hibbert, Walter, 14, Goldhurst-terrace, South Hampstead, N.W.
June 7, 1894		Hichens, J. H., M.A., F.G.S., North Devon Lodge, Cheltenham
Mar. 17, 1881		Hiddingh, Michael, Newlands, near Capetown
May 7, 1891		Hiepe, William L., Ph.D., The Laboratory, Kilvert's Buildings, Withy Grove, Manchester
Dec. 6, 1894		Higgs, M. S., Clarence House, Russell-street, Gloucester
March 16, 1882		Hill, Alexander, Campanas, 15, Cordova, Spain
Dec. 16, 1858		Hill, Alfred, M.D., F.I.C., F.R.S.E., Medical Officer of Health, The Council House, Birmingham
Feb. 15, 1894		Hills, Edmond Herbert, Captain R.E., Darland House, Chatham
Mar. 5, 1892		Hills, Harold F., 149, Bow-road, London, E.
May 15, 1873		Hills, Walter, 225, Oxford-street, W.
May 5, 1892		Hinnell, Henry Leonard, Messrs. Thwaite, Tozer and Co., Moorfields-chambers, 95 and 97, Finsbury-pavement, E.C.
May 3, 1894		Hirsch, C. T. W., M.D., Government Medical Officer, Fiji
Jan. 20, 1870		Hislop, G. R., Gasworks, Blackstoun-road, Paisley
Nov. 18, 1886		Hislop, Lawrence, 33, Slatey-road, Birkenhead
June 21, 1883		Hobbs, Bedo, The Brewery, High-street, Maidenhead
Dec. 18, 1884		Hodges, Herbert J., Stoneleigh, Worple-road, Wimbledon
April 15, 1844	Trans.	Hodges, John F., Prof., M.D., F.I.C., J.P., Queen's College, Belfast, and Sandringham, Malone-road, Belfast
Nov. 16, 1882	Trans.	Hodgkin, John, F.L.S., F.I.C., 12, Dynevor-road, Richmond-on-Thames
Dec. 18, 1879	Trans.	Hodgkinson, W. R. Eaton, Prof., Ph.D., F.R.S.E., 8, Park-villas, Blackheath, S.E.
April 15, 1886		Hodgson, Christopher, High House, Eppleby, Darlington
April 17, 1873		Hodgson, H. Tylston, Harpenden, Herts
Dec. 6, 1894		Hogg, A. F., M.A., 73, Stanhope-road, Darlington
May 7, 1885		Hogg, Edward Grindle, 1, Southwick-street, Hyde Park-square, W.
Mar. 1, 1883		Hogg, W. Douglas, M.D., 62, Champs Elysées, Paris

Date of Election.		
April 17, 1890		Holburn, A., Cowan, B.Sc., 10, West-garden-street, Glasgow
June 11, 1876		Holcroft, Harold, M.A., Parkdale, Wolverhampton
Dec. 3, 1885		Holgate, Thomas, 12, Hyde Park-road, Halifax
Mar. 16, 1876		Holland, Philip, 22, Taviton-street, Gordon-square
Dec. 3, 1891		Holliday, John, The Gas Works, Scarboro
Dec. 2, 1880		Holliday, Robert, Huddersfield
June 18, 1891		Holloman, Frederick R., 396, Barking-road, Plaistow, E.
Mar. 4, 1886		Holloway, George Thomas, 57 and 58, Chancery-lane, W.C.
Feb. 15, 1894		Holmes, John Winder, 28, Crooms hill, Greenwich, S.E.
Dec. 2, 1886		Holt, George Crompton,
June 7, 1894	Trans.	Holt, Wilmot, jun., c/o Mr. Henderson, Esp Hill, Haydon Bridge, Northumberland
Dec. 7, 1893		Holthouse, H. B., 42, St. Ann's-valley, Nottingham
May 4, 1865		Holzmann, M., Ph.D., Marlborough-house, S.W.
Feb. 7, 1878		Hooker, A. H., Board of Health, Cairo, Egypt
Dec. 15, 1892	Trans.	Hooker, Samuel C., The Franklin Sugar Refinery Co., 701, Front-street, Philadelphia
Mar. 1, 1883		‖Hooper, David, Ootacamund, Madras Presidency, India
May 17, 1888		Hooper, E. Grant, 16, Royal-avenue, Chelsea, S.W.
Feb. 19, 1891		‖Hooper, Ernest F., Elmleigh, Beckenham
June 7, 1894		Hope, Arthur Peach, Pytchley Manor, near Kettering
May 7, 1885		Hope, Charles Frederick, Prof., M.R.A.C., Lindesforne, Weymouth
Feb. 15, 1894		‖Hornby, R., B.A., The High School, Newcastle, Staffordshire
Dec. 15, 1892		Horsfall, John, Plantation House, Cloughfold, Manchester
Dec. 15, 1892		Horwill, Edgar E. C., Firs Villa, Fitzwilliam-road, Clapham, S.W.
Mar. 4, 1886		‖Hoskins, Arthur Percy
Dec. 7, 1882		Hotblack, Herbert A., Cannon Brewery, Brighton
Feb. 16, 1871		Houlder. W. W., 10, Ossulton-villas, Southall-green, Southall
Mar. 17, 1887	Proc.	Houlding, William, B.Sc., Stanley House, Anfield, Liverpool
Dec. 7, 1882		‖Howard, Alfred G., Holmbury, Woodford-green, Essex
Feb. 18, 1869		Howard, Alfred Kingsby, Bryntirion, Rhyl, North Wales
Nov. 3, 1870	Trans.	Howard, David, Devon House, Buckhurst Hill, Essex
April 21, 1887		‖Howard, D. Lloyd, jun., Alton Lodge, Woodford-green, Essex
Dec. 18, 1879		Howard, John, 22, Ashby-road, Canonbury
Mar. 4, 1875		Howard, Thomas, 50, Ellington-street, Liverpool-road, N.
June 20, 1889		Howard, George William, Calverley, Tunbridge Wells
Dec. 7, 1882		Howe, J. Lewis, M.D., Ph.D., Prof. of Chem., Washington, and Lee University, Lexington, Va., U.S.A.
Feb. 19, 1880		Howell, Reginald, 95A, Southwark-street, S.E.
Jan. 20, 1876		Howie, W. L., Cornbrook House, Clarendon-road, Eccles, Lancashire
Jan 15, 1893		Howitt, James J., Messrs. Bowman, Thomson and Co., Northwich

Date of Election.		
April 4, 1889		||Hoyle, Richard Ashworth, 11, Market-square, Lytham, Lancs.
April 4, 1889		Hoyles, Henry Richardson, c/o Messrs. Treacher and Co., Byculla, Bombay, and Fern-place, 142, Upperthorpe, Sheffield
Mar. 2, 1871		||Hudleston, W. H., M.A., F.G.S., 8, Stanhope Gardens, South Kensington, S.W.
Feb. 21, 1895		Hudson, Percy, 48, Alexandra-road, Burton-on-Trent
Feb. 21, 1878		Hudson, William, B.Sc. (Lond.), The Lilies, Twickenham
Feb. 15, 1894		Hughes, Frank, 78, Duke-street, Chelmsford
June 17, 1880		Hughes, George Henry, Analytical Laboratory, Barbadoes, West Indies; and 79, Mark-lane, E.C.
Dec. 17, 1868		Hughes, John, Analytical Laboratory, 79, Mark-lane, E.C.
May 17, 1888		Hughes, John, 16, Finsbury-circus, E.C.
Dec. 5, 1889	Trans.	Hughes, Robert Edward, B.A. (Oxon.), B.Sc. (Lond.), Science and Art Department, South Kensington, S.W., *and* 6, Fairfax-road, Bedford Park, W.
June 4, 1885		Hughes, T. Vaughan, Greenfield Mills, Holywell, North Wales
Nov. 16, 1882		Hughes, Thomas, Borough Analyst, West Wharf, Cardiff; Laboratory, 31, London-square, Cardiff
Nov. 20, 1884		Hulme, James, Newton Chemical Works, Hyde, Manchester
April 19, 1883		Humphrys, Norton H., 4, The Paragon, Wilton-road, Salisbury
Dec. 18, 1879	Trans.	Hummel, J. J., 7, Moorfield-villas, Woodsley-road, Leeds
Dec. 7, 1893		Hunt, Bertram, P.O., Box 1606, Denver, Colorado, U.S.A.
Mar. 18, 1869		Hunt, Charles, Birmingham Gas Light Works, Windsor-street, Birmingham
Feb. 1, 1883		Hunter, John, 29, Chambers-street, Edinburgh
Dec. 3, 1885		Hunter, Matthew, M.A. Oxon, Rangoon College, Lower Burmah
April 4, 1878	Trans.	Huntington, A. K., Prof., Metallurgical Laboratory, King's College, W.C.
Feb. 16, 1893		Huntly, George Nevill, Balliol House, Whitechapel, E.
Dec. 3, 1885		Hurst, George H., 22, Blackfriars-street, Salford
Mar. 21, 1861		Huskisson, H. O., 5, Gordon-square, London, W.C.
Feb. 15, 1894		Hutchinson, Alfred, Lea View, Carlin How, R.S.O., Yorkshire
Feb. 6, 1890	Trans.	||Hutchinson, Arthur M.A., Ph.D., Pembroke College, Cambridge
Jan. 17, 1884		Hutchinson, C. Clark, 193, Romford-road, Stratford, E.
April 12, 1888		Idris, Thomas Howell Williams, Pratt-street, Camden Town, N.W.
Feb. 7, 1867		||Ince, Joseph, 11, St. Stephen's-avenue, Shepherd's-bush, W.
Dec. 15, 1892	Trans.	Ince, Walter H., Ph.D., Port of Spain, Trinidad
April 4, 1889	Proc.	Ingle, Herbert, Poole, near Leeds
Dec. 7, 1871		Irvine, Robert, Royston, Granton, near Edinburgh
Dec. 6, 1883		||Irwin, Wilfred, 3, Wilton Polygon, Cheetham Hill, Manchester

Date of Election.		
Dec. 15, 1892		‖Isaac, John F. V., 114, Marine-parade, Brighton
Feb. 16, 1882		Isherwood, Thomas, B.A., LL.B., University School, Southport
Nov. 19, 1885		Ivatt, Albert, B.A., 21, Willis-road, Cambridge
May 3, 1894		Jackman, Edwin James, 86, Brooke-road, Stoke Newington, N.E.
Feb. 1, 1883		Jackson, Alfred H., B.Sc., Prof., c/o Wm. Bowen and Co., Collins-street, W., Melbourne, Australia
Feb. 15, 1894	Proc.	Jackson, David Hamilton, M.A., B.Sc., bei G. Ganzhorn, Hauptstrasse 87, Heidelberg
Dec. 7, 1882		Jackson, Edward, 27, Beaufort-road, Edgbaston, Birmingham
Dec. 5, 1889		‖Jackson, Eric H., B.Sc., 61, Portland-street, Manchester
Dec. 18, 1884	Trans.	Jackson, Herbert, 3, Amyand Park Gardens, East Twickenham, and King's College, Strand
Dec. 15, 1892		Jackson, John, Rhymney, near Cardiff
Mar. 6, 1890		Jackson, John Charles, M.R.C.S., L.R.C.P., 2, Fulham Park-villas, Fulham, S.W.
Dec. 6, 1883		Jackson, Robert, 18, Harrington-street, Dublin
Dec. 15, 1884		‖Jackson, R. Valentine, c/o The Scotch and Irish Oxygen Company, Polmadie, Glasgow
Dec. 15, 1892		Jackson, Samuel, 7, Mulgrave-terrace, Dalton, Huddersfield
Dec. 15, 1881		Jackson, Wm., F.G.S., 61, Beaconsfield terrace, Northampton
June 16, 1887		‖Jadhava, K. B., Baroda, Bombay Presidency, India
May 16, 1878		Jago, William, F.I.C., 32, Clarendon-villas, Brighton
Feb 18, 1888	Trans.	‖James, Christopher, care of Elliott's Metal Company, Pembrey Copper Works, R.S.O., Bury Port, South Wales
Feb. 17, 1881	Trans.	James, J. William, Ph.D., 29, Redcliffe-street, Bristol
Feb. 7, 1878		Jamieson, Alexander, 5, St. Mark's-crescent, Regent's Park, N.W.
Feb. 6, 1879	Trans.	†‖Japp, F. R., M.A., LL.D., Ph.D., F.R.S., University, Aberdeen
Feb. 15, 1894		Jardine, Walter, 86, Victoria-place, Perth
Nov. 16, 1882		J'armay, Gustav, Hartford Lodge, Hartford, Cheshire
Feb. 19, 1891		Jenkins, Henry Charles, Royal Coll. of Science, S. Kensington, S.W.
Nov. 20, 1890		Jenkins, Wallis, 9, Arnold-street, Aulaby-street, Hull
May 5, 1887		Jenkins, John H. B., Chemical Laboratory, G.E. Ry. Works, Stratford, E.
Feb. 15, 1894		Jenks, R. Leonard, Esq., 33, Cautley-avenue, Clapham Common, S.W.
Feb. 15, 1894		Jennison, Francis Herbert, Hollywell House, Theaker-lane, Armley, near Leeds
April 17, 1879		Jewson, Francis A. B., Homefield, Station-road, Clapham
Feb. 4, 1875		‖Johnson, David, F.G.S., F.R.M.S., 11, Thurlow-terrace, Larkhill-rise, Clapham, S.W.

† Longstaff Medallist, 1891.

Date of Election.		
Feb. 21, 1878	Trans.	Johnson, George Stillingfleet, 11, Savile-row, W.
Feb. 1, 1883		Johnson, James Edward. 40, Edmiston-road, Stratford, E.
May 16, 1872		Johnson, John Grove, 41, Cross-street, Finsbury, E.C.
May 20, 1886		Johnson, J. T., Oakham School, Rutland
Dec. 6, 1883		Johnson, Samuel, 174, Queen's-road, Everton, Liverpool
May 10, 1866		Johnson, Samuel H., Warren Hill House, Loughton, Essex
Dec. 18, 1884		Johnstone, James D., Moss Bank, Fettercairn, Lawrence-kirk, N.B.
April 17, 1879		Johnstone, William, Ph.D., Effingham House, Arundel-street Strand, W.C.
Dec. 15, 1892		Johnston, William George, c/o Messrs. Warwick's, The Brewery, Newark-on-Trent
May 20, 1886		Jones, A. Wentworth, M.A. Oxon. The Currie Schools, Folkestone
April 6, 1871	Trans.	Jones, E. W. T., The Oaklands, Wolverhampton; and 10, Victoria-street, Wolverhampton
Dec. 4, 1873	Trans.	Jones, Francis, F.R.S.E., Beaufort House, Alexandra Park, Manchester
Dec. 6, 1894		‖Jones, Geo. Cecil, Fylton, Bristol
May 4, 1876	Trans.	‖Jones, H. Chapman, Royal Coll. of Science, S. Kensington, S.W.
May 4, 1893		Jones, Hedley Gordon, 18, Ingham-road, W. Hampstead, N.W.
May 16, 1878		Jones, Henry Williams, 17, White-street, Coventry
May 15, 1890		Jones, John Archyll, B.Sc., 9, Granville-road, Middlesborough
Feb. 19, 1891		Jones, M. William, 50, Mayfield-road, Whalley Range, Manchester
Feb. 18, 1892	Trans.	Jones, Lionel Manfred, St. Dunstan's College, Catford, S.E.
May 7, 1891		Joseland, Walter Herbert, Talke, near Stoke-on-Trent, Staffs.
Feb. 21, 1895		Joseph, Edgar, 42, Brondesbury-road, Kilburn, N.W.
May 4, 1893	Trans.	Jowett, Hooper A. D., B.Sc., 17, Bloomsbury-square, W.C.
Feb. 21, 1891		Jowett, William Hall, 2, Mayfield-road, Aigburth, near Liverpool
Dec. 15, 1892		Kacker, Kunwar K.
May 4, 1893		Káká Sorabji, Manekji, Devon Villa, Karachi, Sind, India
Dec. 16, 1886	Trans.	Kawakita, Michitada, Engineering College, Tokyo, Japan
Feb. 17, 1881	Trans.	Kay, William E., Gowanbank, Busby, near Glasgow
June 2, 1856		Kay, William, Rev., B.A., 114, Mount-street, Grosvenor-square, W.
Dec. 5, 1889		Kaye, James R., M.D., Medical Officer of Health, Town Hall, Huddersfield
Dec. 20, 1883		‖Keeling, Frank, Miller Brewing Co., Rochester, N.Y., U.S.A.
Dec. 7, 1882		Keen, Austin, 13, Lyndewoode-road, Cambridge
May 3, 1894		Kellas, Alex. Mitchell, 24, Cecile-park, Crouch Hill, N.

Date of Election.		
Mar. 19, 1874		Kellner, William, Ph.D., Chemical Department, Royal Arsenal, Woolwich, S.E.
May 3, 1894		Kelly, Jno. Abr., Residency, Hyderabad, Deccan, India
April 1867		‖Kemp, David Skinner, 52, Coverdale-road, Shepherd's Bush, W.
May 4, 1882		Kemp, William Joel, Mountfield, Robertsbridge, Sussex
Dec. 18, 1884		Kendall, George Frederic, B.A., The Hollies, Stratford-upon-Avon
Dec. 17, 1874		Kendall, James Alfred, 3, Ashlake-road, Streatham, S.W.
Dec. 5, 1889		Kenwood, Henry R., M.B., C.M. (Edin.), L.R.C.P. (Lond.), 9, Alexandra-villas, Finsbury Park, N.
Feb. 21, 1895		Kenyon, Rich. E., B.Sc., Ashville Coll., Harrogate
Dec. 20, 1883		Kerry, William H. R., Wheatlands, Windermere
April 15, 1875		Keyworth, George Alexander, St. Hilary, Hastings
Dec. 7, 1882		Kilner, Frederick James, Royal Infirmary, Bristol
Jan. 17, 1884		Kilpatrick, W. Stirling, 4, Annfield-place, Glasgow
Feb. 15, 1872	Trans.	‖Kinch, Edward, Royal Agricultural College, Cirencester
Feb. 17, 1881	Trans.	King, Alfred John, Ingersley Vale, Bollington, near Macclesfield
Mar. 15, 1888		King, C. Millard, 21, Godliman-street, E.C.
Dec. 7, 1876		King, J. F., Laboratory of City Analyst, Edinburgh
Feb. 21, 1895		Kingdon, G. Holman, B.A., Taddyforde House, Exeter
Dec. 5, 1872	Trans.	Kingzett, Charles T., Elmstead Knoll, Chislehurst, Kent
Mar. 1, 1877		Kinninmont, Alex., 21, Abbotsford-place, Glasgow
May 7, 1891	Trans.	‖Kipping, F. Stanley, Ph.D., D.Sc. (Lond.), 7, Milburne-grove, South Kensington
Dec. 2, 1886		Kirby, Herbert E., 307, High Holborn, W.C.
May 15, 1890		Kirk, Oliver, 11, Cavendish-place, Carlisle
Feb. 21, 1895		‖Kirkaldy, Patrick H., 68, East India-road, Poplar, E.
Feb. 2 1888	Trans.	Kirkland, J. Booth, Princes-hill, Carlton, Melbourne, Victoria
May 17, 1888		Kirkman, Henry James, Landore, Alkali Works, Swansea
June 19, 1873		‖Kitchin, Archibald, F.I.C., Scragill House, Whitehaven
May 16, 1889		Kitchin, John, The Middlesex Hospital, W.C.
Dec. 6, 1888		‖Knaggs, Alfred Battye, 65, Bellevue-road, Leeds
June 20, 1889		Knight, Frederick Charles, Boston and Colorado Smelting Company, Argo, Colorado, U.S.A.
May 3, 1894		Knight, Wm. Albt., Sexey's Trade School, Bruton, Somerset
May 16, 1878		Knights, James West, County Laboratory, Cambridge
Dec. 5, 1889		Knott, Frederick Thomas, The Laurels, Eltham-road, Lee, S.E.
Dec. 18, 1879		Knowles, Joshua, Stormer-hill, Tottington, Bury
Dec. 15, 1892		Knowles, Thomas Torrens, 23, Croxteth-grove, Sefton Park, Liverpool
June 16, 1864		Knox, G. W., B.Sc., 16, Finsbury-circus, London, E.C.
Feb. 6, 1873		Koch, Walter Edward, M.A., F.G.S., Sharpsburg, Allegheny Cy., Pa., *and* 65, Sandusky-street, Allegheny, Pittsburgh, Pa.
Nov. 17, 1887		Koga, Yoshimasa, The Imperial Mint, Osaka, Japan

Date of Election.		
June 17, 1886	Trans.	Kohn, Charles A., Ph.D., B.Sc., Chemical Laboratory, University College, Brownlow-street, Liverpool
June 8, 1885		Koningh, Leonard de, 325, Kennington-road, S.E.
Dec. 15, 1892		Krause, Dr. G., Cothen, Germany
Feb. 17, 1859	Trans.	Kynaston, Josiah W., Chemical Laboratory, 3, Oak-terrace, Beech-street, Liverpool
Dec. 6, 1894		Ladeil, R. S., 4, Colquitt-street, Liverpool
Feb. 3, 1859		‖Lackersteen, Mark Henry, M.D., M.R.C.P. Lond., M.R.C.S. Eng., F.L.S., Medical School, and 163, State-street, Chicago, Illinois, U.S.A.
Feb. 16, 1888		Lafosse, Charles R., Abbotsford, Wildercombe Park, Ilfracombe
May 4, 1893		Lamb, Edmund George, M.A., Old Lodge, Salisbury
Dec. 15, 1892		‖Lamb, Thornton Charles, The Polygon, Ardwick, Manchester
Feb. 16, 1893		Lambert, Wesley, Hotel de Byzance, Rue de Pera, Constantinople, Turkey
Jan. 18, 1877		Lancaster, William James, F.R.A.S., F.R.C.S., F.R.M.S., The Hollies, Handsworth Wood, Birmingham
Mar. 4, 1886		Lang, William, 73, Queen-street, Glasgow
June 18, 1885		Langer, Charles, Ph.D., Lindisfarne, New Warwick-road, Leamington
May 7, 1891		‖Langham, Rev. E. Norman, M.A. (Cantab), F.L.S., Head Master, Rastrick Grammar School, Brighouse
June 21, 1877	Trans.	Lapraik, William, Ph.D., F.I.C., 18, Dagmar-road, Camberwell, S.E.
Feb. 16, 1894		Lapworth, Arthur, 13, Duchess-road, Edgbaston, Birmingham and 9, Spencer-road, Putney, S.W.
June 21, 1883		Lascelles, B. P., B.A., Harrow
April 15, 1880		Last, Frank B., Laboratory, 78, Mansell-terrace, Swansea
May 7, 1891	Trans.	Lauder, Alexander, 12, Lyle-street, Greenock
Mar. 4, 1886	Trans.	Laurie, Arthur P., Woodside, Baldwin Hill, Loughton
Nov. 16, 1876		‖Law, Channell, Ilsham Dene, Torquay
Feb. 6, 1890		Law, Robert, F.R.M.S., The Royal Mint, Melbourne
June 17, 1850	Trans.	‖Lawes, Sir John Bennet, F.R.S., Rothamsted, near St. Albans
June 17, 1880	Trans.	Lawrance, Henry Awbrey, 28, Grosvenor-road, Gunnersbury, W.
Jan. 19, 1882		Laws, J. Parry, F.I.C., Laboratory, 32, Holborn Viaduct, E.C., and 3, Fyfield-road, Oxford
Feb. 2, 1888	Trans.	‖Lawson, Thomas Atkinson, Ph.D., B.Sc., 114, Alexandra-road, N.W.
April 17, 1890		‖Laycock, William Frederick, Ph.D., 2, Park street, Dewsbury
April 17, 1890		Lea, A. Sheridan, D.Sc., F.R.S., Caius College, Cambridge
Dec. 16, 1886		Leach, Walter, 21, St. Andrew's-place, Bradford
Dec. 6, 1894	Trans.	‖Lean, Bevan, D.Sc., Dalton Hall, Victoria Park, Manchester

Date of Election.		
April 4, 1889		Leaper, Clement Joseph, 19, Belvidere-road, Taunton, Somerset
Feb. 2, 1888		Lease, Frank E., Melapi Estate, Sandakan, British North Borneo
Dec. 3, 1891	Trans.	Leather, J. Walter, Ph.D., Dehra Dun, N.W.P., India
Dec. 5, 1889		Ledingham, L. Napier, Longley Farm, Longley, near Sheffield
Feb. 15, 1894		Lee, Clifford W., c/o W. H. Lee, Oaklands, Dewsbury
Dec. 6, 1883		Lee, Herbert C., The New Westminster Brewery Company, Earl-street, Horseferry-road, S.W.
Feb. 1, 1883		Lee, Robert Brewer, B.Sc., B.A., 6, Warwick-street, Kensington, W.
June 18, 1891		Leeds, Frank H., 26, East Bank, Stamford-hill, N.
Feb. 6, 1873		Lees, Charles, Grange College, Leominster
Dec. 1, 1887		Lees, Samuel, jun., Lyndhurst, Smallshaw, Ashton-under-Lyne
Dec. 3, 1891		Leffler, Rudolf, 21, Havelock-street, Sheffield
May 16, 1889		|Legg, John Edmund, M.A., F.I.C., The Grammar School, Woodbridge, Suffolk
May 7, 1891	Proc.	Leicester, James, 8, Richmond-terrace, Clifton, Bristol
Jan. 17, 1889		Leigh, Cecil, Birmingham Small Arms and Metal Company, Adderley Park Rolling Mills, Birmingham
Dec. 1, 1887		Lennox, David, M.D., 144, Nethergate, Dundee
Dec. 3, 1891		Lennox, Robert N., 3, Inverness-terrace, Fulham, S.W.
Jan. 17, 1889		Lenox, Lionel R., Ph.B., Leland Stamford University, Palo Alto, Santa Clara County, California
June 17, 1886		Leon, John Temple, 38, Portland-place, W.
Feb. 15, 1894		Leonard, Norman, B.Sc., 2A, Lorne-road, Brixton, S.W.
Jan. 19, 1882		Lescher, Frank Harwood, 60, Bartholomew-close, E.C., and 31, Devonshire-place, W.
April 17, 1890		Lescher, Herman, 61, Egerton-gardens, South Kensington
Feb. 6, 1879	Trans.	Letts, Edmund Albert, Ph.D., Queen's College, Belfast
Mar. 15, 1888	Trans.	Lewes, Vivian B., 19, Park-row, Greenwich, S.E.
Mar. 20, 1884		Lewis, A. E., 86, Tritonville-road, Sandymount, Dublin
Nov. 18, 1869	Trans.	‖Lewis, W. J., Mineralogical Museum, Cambridge
Feb. 16, 1888	Trans.	Lewkowitsch, Julius, Ph.D., Lancaster-avenue, Fennel-street, Manchester
Feb. 21, 1878		Lichtenstein, T., Chemical Works, Silvertown, E.
April 15, 1880	Trans.	Liepmann, Henry, Ph.D., c/o P. Shaw Liepmann, Esq., 23, Leadenhall-street, E.C.
May 5, 1892		Lindley, Hubert Edward, 22, Charteres-road, Finsbury-park, N.
Mar. 5, 1874		Linford, J. S., 16, Gladstone-street, Anlaby-road, Hull
April 15, 1886	Trans.	Ling, Arthur R., 45, Lambton-road, Cottenham Park, Wimbledon
May 5, 1892		Lintern, Albert A., B.Sc., Kendrick School, Reading
Nov. 21, 1853	Trans.	‖Liveing, G. D., M.A., F.R.S., Cambridge
Nov. 7, 1872	Trans.	|Liversidge, Archibald, F.R.S., Prof., University, Sydney, New South Wales
June 21, 1883		Livingston, W. J., London County Council, Spring-gardens, S.W.

Date of Election.		
Feb. 19, 1880	Trans.	‖Lloyd, Alfred, The Dome, Bognor, Sussex
Feb. 3, 1876	Trans.	Lloyd, F. J., Agricultural Laboratory, 4, Lombard-court, E.C.
May 4, 1893		Lloyd, Herbert, The Electric Storage Battery Co., Drexel Building, Philadelphia, U.S.A.
Feb. 16, 1871		Lockyer, William John, 7, St. Julian's Farm-road, West Norwood, S.E.
Mar. 20, 1884		London, J. Edward, M.D., 62, Main-street, George Town, Demerara
April 18, 1872		‖Longstaff, George Blundell, M.A., M.B. Oxon., M.R.C.P., Highlands, Putney Heath, S.W.
Dec. 15, 1881		‖Looker, Percy,
Feb. 20, 1873		Loram, H. Y., 19, Hillside-road, Stamford Hill, N.
Feb. 7, 1878	Trans.	‖Louis, D. A., 77, Shirland gardens, Maida Vale, W.
May 4, 1882		Love, Edward G., Ph.D., 80, East 55th-street, New York, U.S.A.
June 15, 1882		‖Lovibond, Thomas Watson, F.I.C., The Tyne Brewery, Newcastle-on-Tyne
Dec. 18, 1884		Low, Charles William, M.B., Stowmarket
Dec. 15, 1856		‖Lowe, Charles, Summerfield House, Reddish, near Stockport
Feb. 21, 1878		‖Lowe, Walter Bezant, M.A., Stranraer School, Wickham, near Fareham, Hants
Feb. 3, 1876		Lowe, William Foulkes, A.R.S.M., 9, Hough-green, Chester
Dec. 6, 1888		Lowman, Oscar A. B., Ph.D., 424, Brush-street, Detroit, Michigan U.S.A.
Feb. 15, 1894		Lucas, E. W., 6, Chelsea-gardens, S.W.
Dec. 3, 1891		Ludlow, Lionel, The Cape Copper Co., O'okiep, Namaqua-land, Cape of Good Hope and Southville, Swansea
Feb. 15, 1877	Trans.	Luff, A. P., M.D., B.Sc. (Lond.), 31, Weymouth-street, Cavendish-square, W.
Mar. 6, 1890	Trans.	Lumsden, John S., B.Sc., 5, Paradise-road, Dundee
Dec. 5, 1867	Trans.	Lunge, Dr. George, Polytechnicum, Zürich, Switzerland
Dec. 4, 1890	Trans.	Lunt, Joseph, B.Sc., 5, South-view, Eccleston-road, Ealing Dean, W.
Dec. 5, 1872	Trans.	‖Lupton, Sydney, Grove Cottage, Roundhay, Leeds
Feb. 30, 1894		Luty, Arthur, 30, Bryn-y-Mor-terrace, Swansea
Feb. 16, 1893	Proc.	Luxmoore, Charles M., B.Sc., 35, Casseldon-road, Willesden, N.W.
May 1, 1873		Lyon, J. B., Brigade Surgeon, East India, U. S. Club, 16, St. James's-square, S.W.
Feb. 19, 1874		Lyon, J. G., The Aire Tar Works, Knottingley, Yorks
Nov. 18, 1886	Trans.	Lyons, Albert Brown, A.M., M.D., Honolulu, Hawaiian Islands
Feb. 3, 1859		‖Lyte, F. Maxwell, F.I.C., A.I.C.E., 60, Finborough-road, Kensington, S.W.
Feb. 16, 1888		Maben, Thomas, 5, Oliver-place, Hawick

Date of Election.		
June 20, 1878		Macadam, C. T., The Lake, Snaresbrook, Essex
Feb. 21, 1853		Macadam, Stevenson, Ph.D., F.R.S.E., Surgeons' Hall, Edinburgh
Feb. 2, 1888		||Macadam, Stevenson, J.C.G., jun., Surgeons' Hall, Edinburgh
April 4, 1878		Macadam, W. Ivison, F.R.S.E., Professor New Veterinary College, Surgeons' Hall, Edinburgh
Dec. 2, 1886		Macan, Hugh, M.A., County Hall, Kingston-on-Thames
April 17, 1890		||MacArthur, J. Stewart, 12, Knowe-terr., Pollokshields, Glasgow
Feb. 15, 1894		Macdonald, A. H., Bagshot House, College-road, Cheltenham
May 7, 1891		MacDonald, William, Tung Wen Kwan, Imperial Coll., Peking
Mar. 4, 1886		MacEwan, Peter, 4, Gresley-road, Hornsey-lane, N.
June 18, 1891		Macfie, R. A. Scott, M.A. (Cantab), B.Sc., Rawcliffe R.S.O., Yorks
Feb. 21, 1895		MacFarlane, Alex., 149, Manx-terrace, Blackley, Manchester
Dec. 2, 1880		Macfarlane, James A., Hacienda de San Pesenal, El Chico, Hidalgo, Mexico
Mar. 6, 1890		Macintyre, Alfred E., St. John's, N.B., Canada
June 17, 1875		Mac Ivor, R. W. Emerson, 67, Great Clyde-street, Glasgow
Dec. 2, 1886		Mackay, J. B., Lillie Prof. A.K.C.L., Director of the School of Mines, Sandhurst, Victoria, Australia
Dec. 4, 1890		Mackean, William, 14, Palmer-street, Westminster, S.W.
Dec. 3, 1874		Mackenzie, D. C., 106, Leadenhall-street, E.C.
Feb. 18, 1892		Mackenzie, Dr. William Cossar, Tewfikieh College of Agriculture, Ghizeh, Cairo
Mar. 5, 1885		Mackey, Wm. McD., Victoria-chambers, South-parade, Leeds
Jan. 15, 1844		Maclagan, Douglas, Sir, M.D., F.R.S.E., University of Edinburgh, and 28, Heriot row, Edinburgh
Jan. 17, 1889		MacLeroy, Arthur Lloyd, M.A. (Oxon), L.S.A., Oakford House, King's Teignton, near Newton Abbot, South Devon
April 17, 1879		Macmillan, J. L., 1, Mangoe-lane, Calcutta
Feb 17, 1881		MacMunn, Charles A., M.A., M.D., F.R.M.S., Oakleigh, Wolverhampton
Feb. 1, 1880		Macnab, William, 14, Great Smith-street, Westminster, S.W.
June 4, 1885	Trans.	Macnair, Duncan Scott, Ph.D., B.Sc., 2, Grosvenor-terrace, Hillhead, Glasgow
April 19, 1888		MacSwiney, E., 13, North Main-street, Cork
Feb. 6, 1890		Mactaggart, James Guthrie, care of Messrs. Boustead and Co., Singapore
April 21, 1864	Trans.	||Mactear, James, F.R.S.E., 2, Victoria-mansions, Westminster, S.W.
May 1, 1862	Trans.	Madan, H. G., Bearland House, Gloucester
June 21, 1888	Trans.	Maiden, Joseph Henry, Curator, Technological Museum, Sydney, N.S.W.
May 5, 1892		Major, George Harry, Devonshire-street, Ardwick, Manchester
Dec. 6, 1894		Makin, C. J. Shaw, Pension International, Wiesbaden

Date of Election		
May 7, 1885		‖Mallet, F. R., 18, The Common, Ealing, W.
Dec. 17, 1857	Trans.	Mallet, J. W., Ph.D., M.D., F.R.S., University of Virginia, Albemarle Co., Va., U.S.N.A.
Feb. 4, 1858		‖Manning, F. A., 18, Billiter-street, E.C.
May 3, 1894		Mansell, James, B.A., 49, Upper Tichborne-street, Leicester, and Chesterfield Grammar School
Feb. 7, 1853	Trans.	Marcet, W., M.D., F.R.S., Flowermead, Wimbledon Park, S.W.
Feb. 16, 1893		Marsden, Fred, Ph.D., Bangor, North Wales
June 16, 1881		‖Marsh, Charles W., Ph.D., 126, Liberty-street, New York, U.S.A.
Feb. 15, 1883	Trans.	Marsh, J. E., M.A., University Museum, Oxford
Feb. 21, 1895		Marshall, Arthur, 60, Fairholme-road, West Kensington
Feb. 6, 1890	Trans.	Marshall, Hugh, D.Sc., F.R.S.E., Chemical Department, University of Edinburgh
Dec. 3, 1891		Marshall, John Willis, Ph.D., M.Sc., Brook Farm, Thornton, Poulton-le-Fylde
Feb. 19, 1891		Marshall, Reginald Tom, 60, Gracechurch-street, E.C.
Nov. 20, 1890		Marshall, T. Rhymer, D.Sc., Chemical Laboratory, St. Mungo's College, Glasgow
Dec. 6, 1888	Trans.	Marshall, William, c/o D. G. Rose, Esq., Samarang, Java
June 16, 1887		Marshall, William, F.I.C., 149, Drake-street, Rochdale
June 15, 1893		Martin, Alexander Mitchell, Douglas-villa, Dunbeth-road, Coatbridge
Nov. 19, 1885		Martin, Lieut.-Col. Gerald Ward, F.R.G.S., 8, Petersham-terr., Gloucester-road, South Kensington, S.W.
Dec. 6, 1883		Martin, W. H., 183, King's-road, Chelsea, S.W.
Feb. 16, 1893		Martin, William J., jun., M.D., University of Virginia, Charlottesville, Va., U.S., N.A.
Feb. 19, 1891		Martin, William Morley, 16, Penryn-street, Redruth, Cornwall
April 7, 1870		Martindale, William, 10, New Cavendish-street, W.
June 1, 1871		‖Martineau, George, 21, Mincing-lane, E.C.
Dec. 1 1887		‖Martineau, Sydney, South-road, Clapham-park, S.W.
June 2, 1851	Trans	Maskelyne, Nevil Story, F.R.S., Salthrop, Wroughton, Wilts
Mar. 2, 1871		Mason, Alfred Henry, F.R.M.S., Seabury Building, 59, Maiden-lane, New York City, U.S.A.
Feb. 6, 1890		Mason, Francis H., The Assay Office, Arlington-place, Truro, Nova Scotia
Mar. 4, 1893		Mason, James, Cambois, Blyth, Northumberland
Nov. 4, 1858		‖Mason, James, Eynsham-hall, near Witney, Oxon
Dec. 5, 1889		Mason, James Braik, 2, Balgay Avenue, Dundee
Dec. 2, 1880		Mason, William Brandwood, 117, Derby-street, Bolton
Jan. 19, 1882	Trans.	Masson, D. Orme, M.A., B.Sc., c/o Dr. Smithers, 24, Buckingham-terrace, Edinburgh
Dec. 4, 1873		Masters, William, Sub-Deputy Opium Agent, Gya, Bengal, India, and 82, Oxford-gardens, Notting Hill, W.

Date of Election.		
June 15, 1876	Trans.	||Matthews, C. G., St. John's Lodge, Beckenham
June 17, 1880	Trans.	Matthews, Francis Edward, Ph.D., Royal Indian Engineering College, Cooper's Hill, Staines, and The Pines, Edgefield Green
Dec. 1, 1887		Matthews, Wm. Edward, Prof., The Stawell School of Mines, Stawell, Victoria, Australia
Jan. 17, 1884		Matthey, Edward, 78, Hatton-garden, E.C.
May 3, 1870		Matthey, George, F.R.S., 78, Hatton-garden, E.C.
Dec. 7, 1893		||Mawer, William Frederick, 16, Fentiman-road, S.W.
Dec. 7, 1865		||Maxwell, Theodore, B.A., M.D. Camb., B.Sc. Lond., 29, Woolwich-common, S.E.
Dec. 1, 1887		||McArthur, John, F.R.S.E., 196, Trinity-road, Wandsworth Common, S.W.
Feb. 2, 1888		McBretney, Edmund G., Pontefract-road, Castleford, York
Feb. 6, 1890		McConnell, Arthur H., 35, Bernard-street, Russell-square, W.C.
Feb. 4, 1875		||McCowan, William, F.I.C., The Brewery, Reading
Nov. 20, 1890		||McCubbin, William A., Mill Bank House, West Derby, Liverpool
Dec. 6, 1894		McCutcheon, Jas., Marchmont, Lanark
Dec. 17, 1857		McDougall, Alexr., 61, Liverpool-road, Birkdale, Southport
Dec. 17, 1874		McDougall, John, Clifton House, Greenwich-park, S.E.
June 15, 1893		McElroy, K. P., 1412, 16th-street, Washington, D.C., U.S.A.
Feb. 18, 1892		McFall, J. E. Whitley, Bankfield-road, West Derby, Liverpool
Mar. 3, 1887	Trans.	McGowan, George, Ph.D., 29, Victoria-parade, Ashton-on-Ribble, Preston
May 4, 1893		McGregory, Joseph Frank, Prof., Hamilton, New York, U.S.A.
June 15, 1893		McKerrow, Charles Alexander, 41, Eccles Old-road, Pendleton, near Manchester
May 5, 1892		McKerrow, William James, D.Sc., 10, Glenmohr-terrace, Hyde Vale, Greenwich, S.E.
Nov. 20, 1890		McKillop, John, 96, Haldon-road, Wandsworth, S.W.
Feb. 6, 1868	Trans.	McLeod, Herbert, F.R.S., Indian Civil Engineering College, Cooper's Hill, Staines
June 7, 1894		McLeod, Jas., 2, Gladstone-terrace, Paisley
Feb. 17, 1881		McMillan, Walter George, Metallurgical Laboratory, Mason College, Birmingham
May 3, 1894		McMullan, Chas., Holywood Co. Down, and Corn Market, Belfast
April 4, 1889	Trans.	||McMurtry, George Cannon, Wallaroo Smelting Works, Wallaroo, S. Australia
Feb. 18, 1882		McRoberts, George, Todhill, Newton Mears, Renfrewshire, N.B.
Feb. 18, 1892		Meacham, Chas. Stephen, Pettridge, Maidstone
Feb. 16, 1871	Trans.	Meldola, Raphael, F.R.S., 6, Brunswick square, W.C.
Feb. 21, 1895		Meldrum, Robt., 27, Lansdowne-road, S.W.
Feb. 15, 1894		Melland, Godfrey, B.Sc., Royal College of Science, South Kensington

Date of Election.		
May 20, 1875		Melmore, Pattinson B., Chemical Laboratory, Maryport
Dec. 18, 1884		Mercer, Francis M., 89, Bishopsgate-street-within, E.C.
Dec. 5, 1889		Mercer, Thomas, Great Hey, Edenfield, near Bury, Lancashire, and Ring Bank Brewery, Edenfield, near Bury
May 7, 1891		Merrils, Frederick Johnson, 371, Glossop-road, Sheffield
April 20, 1876	Trans.	‖Messel, Rudolph, Ph D., Silvertown, Essex
June 21, 1888		‖Miers, Henry A., M.A., F.G.S., Suffield-chambers, 79, Davies-street, Berkeley-square
Feb. 18, 1892	Proc.	Millar, James Hill, c/o Mr. Horace Brown, 72, Chancery-lane, W.C.
Dec. 18, 1843		‖Millar, James,
Feb. 19, 1891		‖Millard, Edgar J., 33, Lothair-road South, Finsbury Park, N.
Feb. 19, 1880	Trans.	‖Miller, A. K., Ph.D., 111, Plymouth Grove, Manchester
Feb. 21, 1889		Miller, Harry East, Ph.D, 1264, Fourteenth-street, Oakland, California
April 4, 1889	Trans.	Miller, James Bruce, A.I.C., Rubislaw Den, North Aberdeen
Dec. 1, 1887	Trans.	Miller, John A., Niagara University, Buffalo, New York
May 7, 1885	Trans.	‖Miller, N. H. J., Ph.D., Harpenden, Hertfordshire
June 15, 1893	Trans.	Mills, Charles, 21, St. Mary Abbotts-terrace, W.
Dec. 18, 1862	Trans.	‖Mills, E. J., D.Sc., F.R.S., Young Professor of Technical Chemistry in the Glasgow and West of Scotland Technical College, 60, John-street, Glasgow
May 7, 1885		‖Milne, Alexander, M.A., M.B., Surgeon, Indian Medical Department, Bombay, and Byculla, Bombay
June 21, 1877		Milne, G. A., Chemical Laboratory, 18, John Brown-street, Bolton
May 5, 1892		Milnes, Ernest E., 16, Ashfield, Bradford
Dec. 1, 1887		Mingaye, John C. H., Department of Mines, Assay Branch, Sydney
May 7, 1891	Proc.	Mitchell, Charles Ainsworth, B.A. Oxon., Fairview, Maberley-road, Upper Norwood, S.E.
June 18, 1891		Mitchell, Thomas, c/o E. Mitchell, Esq., Crossmount, Bridgend, Perth, N.B.
Feb. 16, 1893		Mole, H. Bloome, Hill Side, Shepton Mallet
Feb. 15, 1872	Trans.	‖Mond, Ludwig, F.R.S., 20, Avenue-road, St. John's-wood, N.W.
Feb. 18, 1892		Mond, Robert Ludwig, M.A., F.R.S.E., The Poplars, 20, Avenue-road, Regent's Park, N.W.
Dec. 18, 1879		‖Mondy, Edmund F., Government Engineering College, Howrah, Calcutta, India
May 4, 1893		Monson, Henry John, 15, Palace-street, Buckingham Gate, S.W.
Mar. 3, 1887	Trans.	‖Moody, G. Tattersall, D.Sc., Lorne House, North Dulwich, S.E.
May 5, 1892		‖Moor, Cresacre George, B.A., State Med. Lab., King's College, Strand, W.C.
Feb. 19, 1891		Moore, Frederick Herbert, Strada degli Argentieri, 19, Messina, Sicily

Date of Election.		
Mar. 6, 1890		Moore, Ira, Ph.D., Barn Meadow Mills, Dukinfield, near Manchester
Dec. 15, 1892		Moorwood, Francis Colin, 260, Barnsley-road, Sheffield
Jan. 7, 1888		||Morgan, John James, Riverdale, Abergavenny, Mon.
April 3, 1873		Morgan, William, Ph.D., The Technical Institute, Nelson-terrace, Swansea
Dec. 7, 1893		Morgan, J. R., 57, Coldstream-street, Llanelly
June 17, 1880	Trans.	Moritz, Edward R., Ph.D., 72, Chancery-lane, W.C.
Dec. 18, 1879	Trans.	||Morley, H. Forster, M.A., 47, Broadhurst-gardens, South Hampstead, N.W.
May 5, 1892		Morris, Albert, Fern Bank, Dunkinfield
Feb. 19, 1880	Trans.	Morris, G. Harris, Ph.D., 72, Chancery-lane, W.C., and 18, Gwendwr-road, West Kensington, W.
Dec. 3, 1891		Morris, Joseph, Stamford-street, Mossley, near Manchester
Nov. 4, 1869		Morrison, John, Chemical Engineer, St. Peter's Chemical Manure Works, Newcastle-on-Tyne
May 7, 1891		Morrison, George R., Richmond House, Plaistow, Essex
June 20, 1889		Morrow, Henry W., M.S., Ph.D., 1210, Delaware-avenue, Wilmington, Delaware, U.S.A.
Dec. 15, 1851		Morson, Thomas, 124, Southampton-row, Russell-square, W.C., and 42, Gordon-square, W.C.
Feb. 16, 1872		Morton, Edward Handfield, Campayne-mansions, Campayne-gardens, South Hampstead
Dec. 7, 1893		Morton, Frederick, 101, Quarmby-road, Huddersfield
Feb. 7, 1884		Morton, Percy, Christ College, Brecon, South Wales
April 17, 1890	Trans.	Mosenthal, Henry de, 220, Winchester House, Old Broad-street, E.C.
Jan. 19, 1871		||Moss, John, 30, Tressillian-road, St. John's, S.E.
Jan. 19, 1871		Moss, Richard J., F.I.C., St. Aubyn, Ballybrack, Co. Dublin
Dec. 2, 1880		||Mott, H. A., Ph.D., 61, Broadway, Room 56, New York
April 15, 1886		Moul, Frank, Aldersgate Chemical Works, Southall
June 21, 1888		Mousley, Frank, c/o Mrs. Mousley, 2, Featherston-road, King's Heath, Birmingham
June 18, 1891		Mousley, H. J. Marston, Kingsbury, 19, Larches-street, Camphill, Birmingham
Feb. 16, 1884		||Moyle, R. E., B.A., Heightley, Chudleigh, Devon
June 19, 1884	Trans.	Mueller, Baron Ferdinand Von, K.C.M.G., M. and Ph.D., F.R.S., Melbourne
Jan. 17, 1889		Muir, James, The Yorkshire College, Leeds
Feb. 16, 1871	Trans.	Muir, M. M. Pattison, M.A., Fellow and Prælector in Chemistry, Gonville and Caius College, Cambridge
Mar. 30, 1870		||Muirhead, Alexander, D.Sc., The Lodge, Shortlands, Kent
Feb. 3, 1859	Trans.	||Müller, Hugo, Ph.D., F.R.S., 110, Bunhill-row, E.C.; and 13, Park-square East, Regent's Park, N.W.

Date of Election.		
May 4, 1893		Munby, Alan E., Felstead School, Essex
Mar. 15, 1888		Munroe, Charles E., Prof. Columbia University, Washington, D.C., U.S.A.
Dec. 7, 1871		‖Munro, Donald, M.D., C.M., D.P.H., Medico-Legal Department, University of Glasgow
Feb. 17, 1876	Trans.	Munro, J. M. H., D.Sc., Churchfields, Salisbury
May 4, 1893		Murray, J. Alan, 20, Queen's-road, and University College of Wales, Aberystwyth
Feb. 15, 1894		Murray, John Moore, Esq., Municipal Technical School, Arundel-street, Portsmouth
Jan. 21, 1869		‖Muspratt, E. K., Seaforth-hall, near Liverpool
Dec. 3, 1873		‖Muspratt, Sidney Knowles, 51, Croxteth-road, Liverpool
Dec. 4, 1890	Trans.	Murray, Thomas Smith, D.Sc., Chemical Department, Marischall College, Aberdeen
Nov. 3, 1870	Trans.	Muter, John, M.A., Ph.D., F.R.S.E., F.I.C., Laboratory, 325, Kennington-road, London, S.E., and Winchester-house, Kennington-road, S.E.
Dec. 4, 1890		Myers, Harry C., Ph.D., Stanford University, Palo-Alto, California, U S.A.
Feb. 18, 1892	Trans.	Myers, William Shields, B.Sc., 98, Easton-avenue, New Brunswick, U.S.A.
Mar. 6, 1890		Myles, John, M.A., B.Sc., Principal, Reinet College, Cape Colony
Feb. 3, 1887		Nagel, David Henry, M.A., Trinity College, Oxford
Mar. 5 1874		‖Napier, Arthur S., c o Herren Mayer & Müller, 51, Markgrafen-strasse, Berlin, W., Germany
June 21, 1877		Napier James, 89, London-road, Ipswich
June 15, 1893		Napier, John Watson, Chemical Works, Addiewell, N.B.
Dec. 5, 1878		Napper, Edward W., The Hollies, Vicarage-lane, Bowden
Dec. 3, 1891		Naylor, William, 16, Walton's-parade, Preston
April 4, 1878		Naylor, W. A. H., 38, Southwark-street, S.E.
Dec. 3, 1891		Neilson, Thomas, Utah Furnace and Manfg. Co., Ogden, Utah
Dec. 5, 1889		Nettleton, J. A., 2, Barrows-terrace, The Mount, Belfast
April 4, 1878	Trans.	‖Nevile, R. H. C., Crown Lea, Malvern
June 1, 1871	Trans.	Nevill, Edmund Neville, Gov. Lab., Durban, Natal
April 17, 1890	Trans.	Neville, Francis Henry, Sidney College, Cambridge
June 16, 1892		Newall, John Fenton, 8, Market-place, Manchester
June 4, 1885		‖Newbolt, Francis George, Oakley Lodge, Weybridge
April 19, 1860	Trans.	‖Newlands, John A. R., Laboratory, 27, Mincing-lane, E.C.
Feb. 18, 1864		Newlands, B. E. R., 11, Dunsmure-road, Stamford Hill, N.
Dec. 3, 1891		‖Newlands, William, P. R., 1, Mildenhall-road, Lower Clapton, N.E.

Date of Election.		
Feb. 6, 1890		Newman, William Samuel, The Leez, Madras, India
April 4, 1889		Newsholme, G. T. Wilkinson, 74, Market-place, Sheffield
June 7, 1894		Newth, J. S., Royal College of Science, South Kensington
Dec. 18, 1879		Newton, Howard, Singapore, Straits Settlements
Mar. 4, 1886		Newton, Walter, Park-green, Macclesfield
Mar. 1, 1883		Newton, William, Ph.D., F.I.C., 39, Mincing-lane, London, E.C.
Dec. 15, 1892		Nickolls, J. Bate, The Laboratory, Guernsey
Feb. 16, 1870	Trans.	‖Nicholson, Edward, Brigade Surgeon, 41, Sandy-road, Seaforth, Liverpool
June 4, 1885	Trans.	Nicholson, T. Goddard, B.Sc., M.R.C.S., L.R.C.P., St. Thomas' Hospital, S.E.
Dec. 5, 1889		Nickels, Wallace Christopher, 14, Yew-grove, Cricklewood, N.W.
Feb. 1, 1883	Trans.	Nicol, W. W. J., 15, Blacket-place, Edinburgh
June 7, 1894		Nixon, Alf., General School, Deansgate, Manchester
May 6, 1869		Noble, Captain Sir A., Engineer, Elswick Ordnance Works, Newcastle
Dec. 5, 1889		Norman, John T., 78, Chelverton road, Putney, S.W.
April 4, 1861		Norrington, Frederick, 5, Downfield-road, Clifton, Bristol
June 16, 1892		Norris, Charles James, 24, Ravenscourt-gardens, Hammersmith
April 17, 1879		North, W., M.D., Nedderdale, Chapter-rd., Willesden Green, N.W.
May 5, 1892		Northing, John, The Murrough, Wicklow
Dec. 18, 1854		Norton, Fletcher, Claremont, Huyton, Liverpool
April 4, 1878		‖Norton, Prof. T. H., Ph.D.., University of Cincinnati, Ohio, U.S.A.
June 18, 1891		Notter, J. Lane, M.A., M.D., West Cliff, Woolstone, Southampton

May 4, 1893	Proc.	Oates, William Henry, Broomhall Park, Sheffield
Mar. 4, 1886		Obach, Eugene, Ph.D., F.I.C., 2, Victoria-road, Old Charlton, Kent
May 15, 1890		Oddy, Robert Walter, Waterhouse, Toad-lane, Rochdale
Jan. 19, 1873		Odling, Walter, 132, High-street, and at Messrs. Bass & Co., Burton-on-Trent
Jan. 17, 1848	Trans.	Odling, William, M.B., F.R.S., 15, Norham Gardens, Oxford
May 4, 1871		Ogston, G. H., Analytical Laboratory, 39, Lime-street, E.C.
Dec. 2, 1875		Oman, J. Campbell, Prof., Government College, Lahore, Punjab, India
June 20, 1889		O'Mahony, D. J., Municipal-buildings, Cork
Dec. 4, 1890	Trans	Ormandy, Wm. Reginald, c/o W. Ormandy, 17A, King-street, Wigan
Nov. 4, 1869		Orme, Temple A., University College, W.C.

Date of Election.		
May 16, 1872		‖Ormerod, Joseph Arderne, M.B., M.R.C.P., 25, Upper Wimpole-street, W.
Dec. 6, 1894		Ormerod, T., Sackville-street, Burnley, Lancs.
Dec. 1, 1887		‖Ormiston, Archibald R., Heathland, Uddingston; and 203, St. Vincent-street, Glasgow
June 15, 1893		Orr, Alexander, 109, Pitt-street, Sydney, Australia
Feb. 21, 1884	Proc.	Orsman, W. J., jun., The Roburite Explosives Co., Gathurst, near Wigan
Mar. 17, 1881	Trans.	O'Shea, L. Trant, Firth College, Sheffield
Dec. 1, 1887		Ostersetzer, Julius, Messrs. W. and H. M. Goulding, Manure Manufacturers, Dublin
April 20, 1876	Trans.	†O'Sullivan, C., F.R.S., 140, High-street, Burton on-Trent
Mar. 1, 1883		O'Sullivan, James, 26, Ashby-road, Burton-on Trent
Mar. 17, 1887		‖O'Sullivan, Patrick T., M.B., B.C.L., 34, South Mall, Cork
May 7, 1891		Ough, Lewis, 6, Upper King-street, Leicester
Feb. 16, 1888		Overbeck, Otto G. S. L., 10, Town Hall street, Grimsby
June 16, 1887		Overend, Fred. Lawrence, B.A. (Oxon), Blair Lodge School, Polmont Station, N.B.
Feb. 16, 1893		Owen, Robert Henry, Plas-y-coed, Troedyrhiw, near Merthyr-Tydvil
Dec. 15, 1851		Oxland, Robert, Dr., 32, Portland-square, near Plymouth
Dec. 21, 1871	Trans.	‖Page, Frederick James Montague, B.Sc., 54, Sutherland-street, Pimlico, S.W.
Jan. 17, 1884		‖Pallister, J. W., B.Sc., 22, Grimthorpe-terrace, Headingley, Leeds
May 4, 1882		Palmer, Alfred Neobard, 17, Bersham-road, Wrexham, North Wales
Nov. 19, 1868	Trans.	Palmer, Dr. W. J., 32, Bassett-road, W.
April 19, 1888		Palmer, Henry John, Penleigh House, Cotham Grove, Bristol
April 17, 1879		Palmer, Walter, Westfield, Reading
Jan. 19, 1882		Parker, Joseph R., Avondale, Beaver-road, Ashford
May 3, 1894		Parker, Matt. A., 13, Hamilton-crescent, Partick, Glasgow
Dec. 7, 1882		Parker, R. H., 35, Clifton-road, Maida Vale, W.
Jan. 17, 1889		Parker, Robert Hodgson, c/o Mr. Parker, senr., Buckingham-villa, Keynsham, Bristol
Nov. 20, 1890		Parkes, Thomas, 30, Hopwood-street, Barnsley
Nov. 2, 1865	Trans.	Parkinson, James, F.G.S., Queen's-chambers, Pirie-street, Adelaide, South Australia
May 4, 1893		Parrish, S., 15, Fenton-street, Woodhouse lane, Leeds
Feb. 18, 1892		Parry, Ernest John, B.Sc. 71, Woodside-green, S.E.

† Longstaff Medallist, 1884.

Date of Election.		
May 17, 1888		Parsons, William, Dispensary, St. Bartholomew's Hospital, E.C.
April 21, 1870		Patchett, Isaac, F.I.C., 1, Leopold-square, Leeds
Feb. 15, 1894		Paterson, David, Lea Bank, Roslin, N.B.
Mar. 5, 1885	Trans.	Patterson, George, The Mambré Saccharine Co., Hammersmith, W.
Mar. 17, 1870	Trans.	Patterson, T. L., c/o Messrs. John Walker and Co., Greenock
Dec. 3, 1863	Trans.	Pattinson, John, 75, The Side, Newcastle-upon-Tyne
Mar. 5, 1868	Trans.	‖Paul, Dr. B. H., Analytical Laboratory, 20, Victoria-street, Westminster, S.W.
Dec. 3, 1885	Trans.	Paul, Lewis Gordon, Ph.D., Messrs. Read, Holliday and Sons, Huddersfield
Feb. 15, 1894		Paulusz, Richd., General Hospital, Colombo
Dec. 7, 1893		Payne, George, F.M.D., Atlanta, Georgia, U.S.A.
Feb. 15, 1894		Pearson, William Henry, 5, Bryn-villas, Blaina, Mon.
Jan. 16, 1874	Trans.	Pearce, William, jun., Chemical Works, Bow Common, E.
Feb. 15, 1894		Peden, John, jun., Chemical Laboratory, 11, Duff-street, Greenock
Feb. 4, 1870	Trans.	‖Pedler, Alexander, Prof., Presidency College, Calcutta
May 20, 1886	Proc.	Pendlebury, William Henry, M.A., 6, Gladstone-terrace, Dover
Mar. 7, 1870		Penney, M. D., 11, High-street, Hull
Dec. 16, 1886		Pentecost, Stephen James, Nottingham-road, New Basford, Nottingham
Jan. 17, 1889		Percival, John, M.A., S.E. Agric. Coll., Wye, near Ashford
April 17, 1884	Trans.	Perkin, A. G., 8, Montpelier-terrace, Hyde Park, Leeds
June 18, 1891	Trans.	Perkin, Frederick M., Cheml. Laborat. Univer. of Würzburg, Würzburg, Bavaria
Dec. 15, 1856	Trans.	†‖Perkin, W. H., Ph.D., F.R.S., The Chestnuts, Sudbury, Harrow
April 17, 1884	Trans.	Perkin, W. H., jun., F.R.S., Fairview, Wilbraham-road, Fallowfield, Manchester
Feb. 6, 1890	Proc.	Perman, Edgar Philip, D.Sc., University College, Cardiff, and 1, Gordon-road, Neath, Cardiff
Dec. 6, 1888	Trans.	Perry, George Edward, 6, Norwood-villas, Edgbaston, Birmingham
June 16, 1881		Philip, Arnold, Heriot-Watt College, Edinburgh
Feb. 1, 1887		Phillips, A. G., 18, Fopstone-road, Kensington, S.W.
June 20, 1889		Phillips, Benjamin, 16, Finsbury-circus, E.C., and Oriental Bank-buildings, Bombay, India
Feb. 16, 1882		Phillips, Henry Harcourt, 183, Moss-lane East, Manchester
Feb. 21, 1889		Phillips, Henry Joshua, Palace-chambers, Westminster, S.W.
June 16, 1887		Phillips, J. Stanley H., 6, Albany, Piccadilly, W.
Jan. 16, 1862	Trans.	Phipson, T. L., Ph.D., Laboratory of Analytical Chemistry, Putney, S.W., and Holtham Villa, Putney, S.W.

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† Longstaff Medallist, 1888.

Date of Election.		
Feb. 19, 1891		Pickering, M. Samuel, 38, Price-street, Burslem
Feb. 7, 1878	Trans.	‖Pickering, Percival Spencer Umfreville, M.A., F.R.S , 48, Bryanston-square, W., and Harpenden, Herts
April 17, 1890	Trans.	‖Picton, Harold, B.Sc., 80, Regents Park-road, N.W.
June 7, 1894		Pike, E. Brookes, 6, Harrow-villas, East Ham, Essex
Jan. 15, 1874	Trans.	‖Pike, William Herbert, Ph.D., School of Practical Science, Toronto, Canada
Dec. 20, 1883		‖Pilley, John J., Ph.D., Crescent Lodge, Camberwell Grove, S.E.
Dec. 5, 1889		Ping, William, 2, Sandbourne-road, Brockley, S.E.
Feb. 21, 1889		Pingstone, G. Arthur, Yew Bank, Brook-road, Heaton Chapel, near Stockport
Mar. 17, 1881		Pisani, O. V., Gibraltar-house, Rochmount-road, Upper Norwood
Feb. 16, 1882		Pitt, Theophilus, 16, Coleman-street, E.C.
Feb. 16, 1893		Platt, Charles, Ph.D., Hahnemann's Med. Coll., Philadelphia, U.S.A.
April 4, 1889		Platts, John Charles, Ryecroft Glen, near Dore Station, Sheffield
Nov. 15, 1860		‖Player, J. H., 16, Prince Arthur-road, Hampstead, N.W.
Feb. 23, 1841	Trans.	‖*Playfair, Right Hon. Lord, K.C.B., F.R.S., 68, Onslow-gardens, South Kensington
Dec. 2, 1880	Trans.	Plimpton, R. T., Ph.D., 23, Lansdowne-road, Clapham-road, S.W.
April 1, 1858		Pochin, Henry Davis, Bodmont Hall, Conway, N. Wales
June 7, 1888		Pollard, F. Ernest, Old Cross, Hertford
Feb. 15, 1894		‖Pollok, J. Holms, Castle Grove, The Park, Nottingham
Dec. 4, 1890		Pond, James Alexander, Auckland, New Zealand
Dec. 4, 1848		Pontifex, Edmund A., M.I.C.E., 72, Cornwall Gardens, S.W.
Mar. 6, 1862		Pooley, Thomas A., B.Sc., F.I.C., 121, The Grove, Denmark Hill, S.E.
Feb. 19, 1891	Trans.	Pope, Wm. Jackson, Central Technical College, Exhibition-road, S.W., and 16, Barclay-road, Walham Green, S.W.
Dec. 18, 1884		Porter, T. Cunningham, Rev., Eton College, Windsor
Dec. 6, 1883		Potter, Charles E., c/o Messrs. Tate & Sons, Love-lane Sugar Refinery, Liverpool
Feb. 21, 1895		Powell, H. James, 530, Lordship-lane, S.E.
Feb. 21, 1884		Power, Francis R., The Royal Mint, Melbourne
April 15, 1880		Preller, Charles S. Du Riche, M.A., Ph.D., A.M.I.C.E., F.G.S., 18, Margaret-street, Cavendish-square, W.
May 19, 1864		‖Prentice, Manning, Woodfield, Stowmarket
Mar. 2, 1876	Trans.	Prescott, Albert B., M.D., University, Ann Arbor, Michigan, U.S.A.
May 16, 1861		Prestwich, Joseph, F.R.S., Shoreham, Sevenoaks, Kent
Dec. 5, 1872	Trans.	Prevost, E. W., Ph.D., Elton, Newnham, Gloucester
May 4, 1882		‖Price, Arthur F., 524, Sacramento-street, San Francisco
Jan. 17, 1889		Priestley, Charles W., B.Sc., Vivian Institute, Torquay
Dec. 3, 1891		Priestley, Lawrence, Newark-on-Trent

Date of Election		
Feb. 17, 1870		Pritchard, Prof. William, President Royal Veterinary College, N.W.; and 5, Regent's Park-road, Gloucester-gate, N.W.
June 15, 1871	Trans.	Procter, Henry R., F.I.C., The Yorkshire College, Leeds
April 4, 1889		Proctor, Charles, Upland House, 359, Upland road, Dulwich, S.E.
June 15, 1882		‖Pullar, Rufus D. Ochil, Perth
Feb. 18, 1892	Proc.	Pullinger, William, B.A., Ash Lea, Romiley, Stockport
Nov. 15, 1888	Trans.	Pullinger, Frank, 63, Holywell-street, Oxford
June 21, 1883		Purcell, M. F., 71, Harcourt-street, Dublin
June 3, 1875	Trans.	Purdie, Thomas, Ph.D., B.Sc., Assoc. R.S.M. University, St. Andrews, N.B.
Dec. 2, 1886		Pyke, L. S. M., A.M.I.C.E., M.I.C.E., F.R.I., 44, Kensington Park-gardens, W.

Dec. 2, 1886		Quayle, Edwin, Belmont, 130, Flixton-road, Urmston, Manchester
Mar. 4, 1868		Quibell, Oliver, Magnus Lodge, Newark-on-Trent
Dec. 5, 1889	Trans.	Quincke, Frederick, Ph.D.,
Dec. 6, 1894		Quinn. Gerald G., 16, Albert-street, Newcastle-under-Lyme, Staffs.
Feb. 15, 1891		Quinn, J. Cardwell, c/o Lancashire Rubber Company, Globe Works, Holland-street, Pendleton, Lancs.

April 17, 1879		Rait, George Logan, 5, Fordwych-road, West Hampstead, N.W.
Dec. 15, 1892	Trans.	‖Ramage, Hugh, Royal College of Science, Dublin
Nov. 15, 1888		Ramsay, A. Alexander, Anan Villa, Rose-road, Auckland
Mar. 20, 1873	Trans.	‖Ramsay, W., Ph.D., F.R.S., University College, W.C.
May 7, 1891		Randall, Percy Morrice, 3, Belsize Park-gardens, N.W.
April 18, 1843		Randall, William B., Glenhurst, Archers-road, Southampton
Dec. 3, 1885		Ranken, Charles, Stockton-road, Sunderland
May 16, 1889		Ransom, Francis, 12, Bancroft, Hitchin
April 21, 1887		Rawlins, Edward, 114, Burley-road, Leeds
June 17, 1880		Rawson, Christopher, 2, Melbourne-place, Bradford
Jan. 17, 1884	Trans.	‖Rawson, Sidney George, D.Sc., Westbourne, Westbourne-grove, West Kirby, Cheshire
April 4, 1889	Trans.	Read, Arthur A., 3, Fitzalan-place, Cardiff
Nov. 20, 1890		Redding, Richard James, 17, Leghorn-road, Plumstead, S.E.
Jan. 15, 1874	Trans.	‖Reddrop, Joseph, Laboratory, London and North West. Ry., Crewe
July 16, 1892		Redman, Henry Ramsden, 10, The Gardens, East Dulwich, S.E.
June 20, 1889		Redwood, Robert, 4, Bishopsgate-street-within, E.C.
Jan. 18, 1866		Redwood, Boverton, F.R.S.E., 4, Bishopsgate-street-within, E.C.
Mar. 17, 1887		Redwood, T. Horne, 15, Red Lion-square, W.C.
Nov. 18, 1886	Trans.	Rée, Alfred, Ph.D., 1, Brighton-grove, Rusholme, Manchester
Dec. 7, 1893		Rees, George Percival, Ely House, Basford, Stoke-on-Trent

Date of Election.		
Nov. 16, 1882	Proc.	Reed, Lester, F.I.C., Hyrst-hof, 8, South Park-hill-road, Croydon S.E.
April 15, 1880		‖Regester, William, Lawn-lodge, Isleworth, Middlesex
Dec. 7, 1893		Reid, Thomas Anderson, Lostock, Gralam, Northwich
Dec. 15, 1881		Reid, Walter Francis, Fieldside, Addlestone, Surrey
June 17, 1886		Remington, J. Price, Prof., 1832, Pine-street, Philadelphia, Pa., U.S.A.
Feb. 6, 1879	Trans.	Rennie, Edward H., Ph.D., University of Adelaide, S. Australia
May 17, 1888		Reynolds, Colonel Henry Charles, Thorncliff, Sandown-road, Cheltenham
June 19, 1873	Trans.	Reynolds, James Emerson, Prof., F.R.S., Trinity College, Dublin
Nov. 19, 1857		Reynolds, Richard, 13, Briggate, Leeds
June 18, 1891		Rhodes, Edward, Highfields, Frodsham, Cheshire
May 18, 1876		Richards, D. H., Bryntirion, Oswestry
April 4, 1889		Richards, Duncan T., 3, Madeira-terrace, Westoe-lane, South Shields
Jan. 17, 1889		‖Richards, Edgar, 1621, H. Street, Washington, D.C., U.S.A.
Jan. 17, 1889		‖Richards, Percy A. E., F.I.C., 44, Sinclair-road, Kensington, W.
June 17, 1886		Richards, William, B.Sc., The Clock House, Tooting, S.W.
May 5, 1892		Richardson, Albert Ernest, Fairlight, Knight's-park, Kingston-on-Thames
June 18, 1885	Trans.	‖Richardson, Arthur, 22, Meridian-place, Clifton, Bristol
Feb. 16, 1888		‖Richardson, Clifford, Office of the Engineer Commissioner Central Power Station, G.R.R., Washington, D.C., U.S.A.
Feb. 1, 1883		Richardson, F. W., 2, Farcliffe-place, Bradford
Mar. 6, 1873		Richardson, Henry, Lyndene, Hale-road, Bowdon, Cheshire
Dec. 6, 1888		Richardson, Hubert N. B., The Hawthorns, Knighton Park-road Leicester
April 19, 1866		Richardson, Joseph, jun., 40, Warwick-road, Chorlton-cum-Hardy, Manchester
Dec. 1, 1864		Richardson, J. G. F., Ph.D., Elmfield, Knighton, Leicester
May 5, 1892		Richardson, Reginald E. S., Elmfield, Knighton, Leicester
Nov. 17, 1887		Richardson, W. H., Dudley
Mar. 3, 1887	Trans.	Richmond, H. Droop, 7, Cambrian-road, Richmond
Feb. 3, 1845		‖Rickard, W. T., 136, Maygrove-road, West Hampstead, N.W.
Dec. 6, 1894		Riddick, D. G., Stores Department, G.E.R., Stratford, E.
Dec. 7, 1882	Trans.	‖Rideal, Samuel, D.Sc., F.I.C., 28, Victoria-street, Westminster, S.W.
April 3, 1873		Rider, Alonzo John, 4, Haddington-road, Stoke, Devonport
Feb. 16, 1882	Trans.	Ridsdale, C. H., Hutton-grange, Guisbrough, Yorks
Dec. 6, 1888		Rigby, John S., 35, Bigot-street, Wavertree, Liverpool, and Ditton, Lancashire
Dec. 15, 1851	Trans.	Riley, Edward, 14A, Finsbury-square, E.C.
Dec. 4, 1873		Rimmington, F. M., Bradford

Date of Election.		
May 4, 1893		Rintoul, William, Royal Gunpowder Factory, Waltham Abbey
June 15, 1893		Ritchie, George, 8, Buchanan-gardens, Mount Vernon, N.B.
Mar. 3, 1864		Ritchie, William, jun., Kincaid-field House, Milton of Campsie, Glasgow
May 4, 1893		Robbins, James H., 4, Roderick-road, Haverstock Hill, N.W.
April 13, 1872		Robbins, John, 57, Warrington-crescent, Maida-vale, W.
June 20, 1889		Roberts, Emmanuel, M.D., Moratniva, Ceylon
June 21, 1883		‖Roberts, Frederick G. Adair, Warton-road, Stratford, E.
Jan. 20, 1876		Roberts, Martin Fenn, Postal Telegraph Factory, Mount Pleasant, Clerkenwell, E.C.
April 4, 1889		Roberts, R. Wightwick, c/o A. W. Rowe, Esq., Dashwood House, 9, New Broad-street, E.C.
May 3, 1894		Roberts, Thos. John, 31, North-road, St. Helens, Lancs.
Feb. 19, 1880		Roberts, W. Brittain, Wilderspool House, Warrington, Lancashire
Nov. 7, 1866	Trans.	Roberts-Austen, William Chandler, C.B., F.R.S., Royal Mint, E.
Feb. 15, 1894		Robertson, A. B., Dungayne, Bearsden, by Glasgow
Mar. 17, 1887		Robertson, George, London Hospital, and Madeira-villa, Woodford Green, Essex
Dec. 4, 1890		‖Robertson, George Henry, 30, Hemstall-road, West Hampstead, N.W.
Feb. 21, 1889		Robins, Harry H., Messrs. Southwell and Co., Dockhead, S.E.
May 5, 1881		Robinson, G. Carr, Royal Institution, Hull
Nov. 16, 1882	Trans.	‖Robinson, Henry H., M.A., Imperial College, Hankow, China
Feb. 21, 1895		Robinson, H. Lewin, 9, Lloyd-street, W.C.
May 3, 1866		Robinson, John, Cantley-mansions, Fairhazel gardens, Hampstead, N.W.
June 7, 1894		Robjohns, Herb. Harold, King's School, Pontefract
Dec. 15, 1892		Robson, James, Andersonian-buildings, 204, George-street, Glasgow
Dec. 15, 1892	Trans.	‖Rodger, James Wyllie, 80, Anerley-park, S.E.
Dec. 20, 1883		Rogers, Arthur W., Tadcaster Tower Brewery Co., Tadcaster
Jan. 17, 1884		Rogers, Francis M., 21, Burma-road, Stoke Newington, N.
June 7, 1894		Rolfe, John F., Homewood, Leytonstone
April 15, 1886		Roose, Robson, M.D., 45, Hill-street, Berkeley-square, W.
Dec. 17, 1855	Trans.	Roscoe, Sir H. E., M.P., LL.D., F.R.S., 10, Bramham-gardens, South Kensington, S.W.
Feb. 19, 1891	Trans.	Rose, Tom Kirke, 9, Royal Mint, E.
Feb. 15, 1894		Ross, Arthur, 1, Glengall-road, Old Kent-road, S.E.
Feb. 17, 1870		Ross, Lewis Buttle, Driffield
Dec. 15, 1881		Ross, Rev. Henry, LL.D., Dallas House, Lancaster
June 18, 1891	Proc.	Rossiter, Edmund Charles, 107, St. Paul's-road, Smethwick
Feb. 18, 1892		Rothewell, C. F. Seymour, 88, George-street, Moss Side, Manchester
Mar. 6, 1890		Rothwell, Robert R., 88, George-street, Moss Side, Manchester

Date of Election.		
Feb. 15, 1894		Rouillard, Richard A., 2, Springfield-road, Wimbledon, S.W.
Dec. 19, 1872	Trans.	Routledge, Robert, B.Sc., The North-Eastern Railway Laboratory, Greenfield, Gateshead-on-Tyne
Feb. 15, 1894		Rowntree, Walter Smithson, National Liberal Club, S.W.
June 17, 1880		||Roy, Tarapusauna, Medical College, Calcutta
Mar. 20, 1862		||Royle, Thomas, Dalton House, Upton-lane, Forest Gate, E.
Feb. 15, 1872	Trans.	Ruffle, John, Gnoll Brook, Neath, South Wales
Jan. 17, 1889	Trans.	Ruhemann, Siegfried, Ph.D., M.A., Gonville and Caius College, Cambridge
Feb. 15, 1883		Rumble, Charles, 31, Oberstein-road, New Wandsworth
Feb. 6, 1890		||Russell, Edward, 36, Lucerne-road, Highbury Park, N.
Mar. 3, 1851	Trans.	||Russell, W. J., Ph.D., F.R.S., 34, Upper Hamilton-terrace, St. John's-wood, N.W.; and St. Bartholomew's Hospital, E.C.
June 7, 1894		Ryce, George, B.A., Rathmore-place, Cork
Feb. 16, 1870		||Rylands, Thomas Glazebrook, F.L.S., Highfields, Thelwall, near Warrington
Feb. 19, 1891		Sacré, Howard C., 5, Ecclesford-road, Manchester
June 18, 1868		Sadler, S. A., Dr., Cleveland Chemical Works, Middlesborough
May 4, 1882		Sadtler, Samuel P., Ph.D., 145, North 10th-street, and 1042, Drexel-buildings, Philadelphia, U.S.A.
June 19, 1884		St. Stephen, Raynor, Tregenna House, 25, Fordwych-road, Brondesbury
Dec. 20, 1883	Trans.	||Saint, W. Johnston, Kurfuersten Strasse 5, Bonn-Poppelsdorf, Germany
June 19, 1879	Trans.	||Sakurai, J., Science College, Imperial University, Tokyo, Japan
Feb. 19, 1880		Salamon, Alfred Gordon, 27, Holland-park, W.
May 4, 1876		||Salomons, Sir David Lionel, Broomfield, Tunbridge Wells; and Berkeley Chambers, 13, Bruton-street, Hyde-park, W.
April 16 1863		||Salt, Henry, M.D.C.M., F.R.G.S., Inglewood, Great Malvern
Feb. 17, 1859		||Salter, Thomas W., Hamilton House, The Croft, Hastings, Sussex
June 25, 1871		||Salter, Mortyn John, Northcote, Beaconsfield-road, New Southgate
May 4, 1882		Samuel, W. Cobden, Wilton Lodge, 337, Norwood-road, West Norwood, S.E.
Mar. 3, 1870	Trans.	||Sandberg, C. P., 19, George-street, Westminster
Feb. 18, 1892		Sandercock, Thos. J. Buckler, Sidcup College, Sidcup, Kent
Dec. 6, 1888		Sanderson, John, Middlesborough, Kentucky, U.S.A.
Nov. 16, 1882		Sanford, P. Gerald, Laboratory, 20, Cullum-street, E.C.
Dec. 4, 1890		Saniter, Ernest Henry, Laboratory, Wigan Coal and Iron Co., and 11, Market-street, Wigan
Dec. 3, 1891		Sanyal, Abhayacharan, M.A., Professor of Physical Science, Queen's College, Benares, N.W.P., India
Dec. 15, 1892		Sarbadhicary, Satya-prasad, 1, College-street, Calcutta

Date of Election.		
June 17, 1886		Saunders, Prof. William, Experimental Farm, Ottawa, Ontario, Canada
Feb. 2, 1888		Saunders, W. Sedgwick, M.D., L.R.C.P. Ed., M.R.C.S., F.S.A., Medical Officer of Health for City of London, 13, Queen-street, Cheapside, E.C.
Feb. 6, 1890		Sayers, William Charles, 63, High-street, Lewisham, S E.
Dec. 3, 1885		Scammell, Luther R., 42–4, King William-street, Adelaide, South Australia
June 21, 1877		Scarf, Sydney Isaac, F.I.C., City of London School, Victoria Embankment, E.C.; and 75, Oxford-road, Islington, N.
Feb. 6, 1873		Schacht, George Frederick, 1, Windsor-terrace, Clifton, Bristol
Dec. 7, 1893		Schidrowitz, Philip, 102, Oxford-gardens, Notting Hill
Dec. 6, 1888		‖Schieffelin, William Jay, 170, William-street, New York City, U.S.A.
Dec. 2, 1886	Trans.	Schleselman, James, Victoria-chambers, Dundee
Dec. 15, 1892		Schloesser, Augustus, Ph.D., Storey Institute, Lancaster
Feb. 18, 1892		‖Schofield, James Alexander, University of Sydney, New South Wales
Mar. 15, 1842	Trans.	Schunck, Edward, Ph.D., F.R.S., Oaklands, Kersal, Manchester
Dec. 6, 1894		Scorer, A. G. Flaxmoor, Caston, Attleborough, Norfolk
June 18, 1863		Scorgie, James, Poona Villa, King's Gate, Beechgrove-terrace, Aberdeen
Dec. 18, 1879		‖Scott, Alexander, M.A., D.Sc., Chemical Laboratory, University, Cambridge
April 17, 1890		Scott, Ernest George, 67, Lord-street, Liverpool
Mar. 3, 1887		Scrutton, W., Robinson's Ferry, Calaveras County, California, U.S.A.
Mar. 1, 1883	Proc.	Scudder, Frank, 44, Mosley-street, Manchester
May 7, 1891		Searl, Albert, Montrena, Victoria-road, Sidcup
Nov. 20, 1890		Seaton, Edward Cox, M.D., The Limes, 56, North Side, Clapham Common, S.W.
June 21, 1888		Seely, Herbert W., 11, Corn-market, Halifax
April 15, 1875		Sellon, Scudamore, The Hall, Sydenham, S.E.
Dec. 15, 1892	Trans.	Sell, William James, Univ. Chem. Laboratory, Pembroke-street, Cambridge
Feb. 16, 1882		Sells, V. Perronet, Highfield, New Headington, Oxford
Mar. 4, 1875	Trans.	‖Senier, Alfred, Prof., M.D., Ph.D., Queen's College, Galway
June 21, 1887		Senier, Harold, Braybrook Lodge, Harrow
Mar. 6, 1890		Sergeant, Edward, L.R.C.P. (Lond.), M.R.C.S. (Eng.), County Offices, Preston, Lancashire
June 15, 1893		Sessions, Wilfred, B.Sc., Leighton Park School, Reading
Jan. 20, 1870	Trans.	Seward, Henry, c/o Messrs. J. B. Freeman, Sons, and Co., Wandle Colour Works, Wandsworth, S.W.

Date of Election.		
Feb. 19, 1874		‖Sexton, A. Humboldt, F.I.C., F.R.S.E., Professor of Metallurgy, Metallurgical Department, Andersonian buildings, 204, George-street, Glasgow
June 20, 1880		Shadwell, J. E. L., Meadowbanks, Melksham, Wilts
Feb. 20, 1873		Shapleigh, Waldron, Welsbach Incandescent Gas Light Co., Factory, Gloucester City, New Jersey, U.S.A.
Dec. 7, 1893		‖Shapley, Frederick, c/o Whittier, Fuller, and Co., 21, Front-street, San Francisco, California
June 4, 1874		Sharman, William, 247, Mare-street, Hackney, N.E.
June 18, 1885		Sharp, James, The Towers, Low Moor, near Bradford
Feb. 21, 1895		Sharrott, T. C., 2, Margaretta-terrace, S.W.
Feb. 2, 1888		Shaw, Frederic W., Laboratory, Heapy Bleach Works, near Chorley, Lancashire
Dec. 15, 1892		Shaw, G. Arthur, 45, St. Petersgate, Stockport
Feb. 6, 1890	Trans.	Shaw, Saville, Durham College of Science, Newcastle-upon-Tyne
June, 16, 1887		Sheard, John T., Avenue-place, Brimington, Stockport
April 4, 1889		Shegog, Thomas Alexander, 4, Omsbersley-road, West Park, Newport, Mon.
Feb. 17, 1876	Trans.	Shenstone, W. A., Clifton College, Bristol; and 12, Clifton Park-road, Clifton, Bristol
May 21, 1874		‖Shepherd, H. H. B., Northcote, Mount Pleasant-lane, Upper Clapton, N.E.
Dec. 16, 1886		Sheshadri, P. Y., The Mission House, Bethel, near Jaulna, via Bombay, India
Dec. 15, 1892		Shepherd, Reginald des Forges, 6, Coltman street, Hull
June 18, 1891	Trans.	‖Shields, John, Ph.D., D.Sc., University College, W.C.
Dec. 16, 1886	Trans.	Shimidzu, T., 2111, North Jefferson-street, Peoria, Ills., U.S.A.
April 19, 1883		Shopoff, Vulko Ivan, Philippopolis, South Bulgaria
June 7, 1894		Shorthouse, H. S., 47, Pershore-road, Birmingham
Nov. 18, 1886		Shutt, Frank, M.A., Experimental Farm, Ottawa, Canada
April 17, 1890		Shuttlewood, W. Brewin, 8, Clifton-road, Crouch End, N.
June 7, 1894		Shuttleworth, E. B., Prof., 220, Sherborne-street, Toronto
May 16, 1889		Sibson, Alfred Edward, 3, Osborne-road, Buckhurst Hill, Essex
Dec. 15, 1859		Sibson, Alfred, 23, St. Mary Axe, E.C.
April 17, 1890		Sibun, James, 2, Lax-terrace, Norton, Stockton-on-Tees
Nov. 29, 1874	Trans.	Siebold, Louis, Broomville-avenue, Sale, near Manchester
Dec. 2, 1886		Silvester, Harry, Malvern House, Handsworth, Birmingham
Dec. 3, 1885		Sim, James, 77, Dee-street, Aberdeen
April 4, 1889		Simmonds, Henry, Gas Works, Colne, Lancashire
April 21, 1887		‖Simmons, L. Owen, Wolvesey, Winchester
1857		Simpson, Maxwell, M.D., F.R.S., 9, Barton street, West Kensington
May 29, 1886	Trans.	‖Simpson, William Selby, 95, Darenth road, Stamford Hill, N.

Date of Election.		
Dec. 7, 1893	Trans.	Sims, W. Edgar, c/o Dr. G. Grossman, Hendham Vale Chemical Works, Manchester
May 16, 1889		Singer, Ignatius, The Poplars, Chapel-street, Calverley, Yorks.
April 15, 1880		Skelton, J. R., The Homestead, Thorpe Village, Norwich
Feb. 2, 1888	Trans.	Skinner, Sidney, M.A., The Cavendish Laboratory, Cambridge
Feb. 18, 1892		Skurray, Thomas, United Breweries, Abingdon, Berkshire
April 17, 1879		Slater, Charles, 16, Northwick-terrace, St. John's Wood, N.W.
April 15, 1880	Trans	‖Slater, Harold H., Laboratory and Cement Testing Office, Grays, Essex
Dec. 5, 1878		Slatter, George W., A.R.C.S., F.I.C., 12, Bromley-street, Stapley, Yorkshire
April 4, 1889		Slater, John W., 36, Wray-crescent, Tollington Park, N.
Feb. 5, 1863	Trans.	Smee, A. Hutchinson, The Grange, Hackledge, Carshalton, Surrey
Dec. 16, 1875		‖Smetham, Alfred, Analytical Laboratory, Cereal Chambers, 18, Brunswick-street, Liverpool
Dec. 5, 1872		Smith, A. Percy, 20, Endsleigh-gardens, N.W.
June 21, 1883	Trans.	Smith, Adolphe, 4, Barclay-road, Walham Green
April 17, 1890	Trans.	‖Smith, Alexander, Ph.D., B.Sc., University of Chicago, Chicago, U.S.A.
Feb. 16, 1888		Smith, Angus, 10, Ardgowan-street W., Greenock, N.B.
Dec. 15, 1881	Trans.	Smith, Bernard E., Alkali Acts Department, Local Government Board, Whitehall, S.W.; and 73, Westmorland-road, Newcastle-on-Tyne
Feb. 15, 1894		Smith, Charles Henry, Accra, Gold Coast, West Africa
Dec. 6, 1894	Trans.	Smith, Claude, Fernside, Haveringatte Bower, Romford, E.
Feb. 21, 1884		‖Smith, Edgar Francis, 35, Ampthill-square, Hampstead-road, N.W.
Mar. 20, 1878		Smith, Edgar F., Prof., University of Penna., Philadelphia, Pa.
Dec. 9, 1869		Smith, Edward, Heathfield House, Chudleigh, Devon
June 7, 1894	Trans.	Smith, Ernest A., 17, Oval-road, Regent's Park, N.W.
June 16, 1892		Smith, Ernest Heber, 17, Carlisle-road, Cambridge
Nov. 20, 1892		‖Smith, Fred., P.O. Box 1324, Johannesburg
April 2, 1874		Smith, George, Nobel's Explosives Co., Polmont Station, Scotland
Dec. 20, 1883		Smith, George, 141, Lothair-road, North Finsbury Park, N.
Feb. 18, 1892		‖Smith, George P. Darnell, 80, Woodland-road, Bristol
Feb. 6, 1890		Smith, Harry Wood, B.Sc., Messrs. May and Baker, Garden Wharf, Church-road, Battersea
Mar. 16, 1878		Smith, H. R., 1, Aubert-park, Highbury, N.
May 5, 1892		Smith, John Meadows, Laboratory, 66, College-street, Chelsea, S.W.
Dec. 18, 1879		Smith, John William, Mass. Institute of Technology, Royston-street, Boston, Massachusetts
Feb. 6, 1873	Trans.	Smith, Miles H., 3, Great Titchfield-street, Oxford-street, W.

Date of Election.		
Feb. 19, 1891		Smith, R. Greig, Durham College of Science, Newcastle-on-Tyne
Feb. 16, 1888		Smith, Sam, Ebor, Mount Pleasant-road, Exeter
Nov. 18, 1886		Smith, Sidney, 35. Ampthill-square, Hampstead-road, N.W.
Apr.l 7, 1856		Smith, Thomas J., F.G.S., Wilton-terrace, Hornsea, East Yorkshire
Feb. 3, 1876		Smith, W. A., M.A., M.B. Oxon, M.R.C.S. Eng., Newport, Essex
Dec. 20, 1866	Trans	Smith, Watson, 34, Upper Park-road, Haverstock Hill, N.W.
Dec. 20, 1883	Trans.	Smithells, Arthur, Professor, The Yorkshire College, Leeds
Dec. 18, 1873		‖Smyth, John, M.A., Milltown, Banbridge, Ireland
Mar. 3, 1887	Trans.	‖Snape, Henry Lloyd, Prof., Chemical Laboratories, University College of Wales, Aberystwith
May 16, 1872	Trans.	Snelus, George J., F.R.S., 2, Victoria-mansions, Victoria street. Westminster, and 42, Lowther-street, Whitehaven
Dec. 18, 1879		Snodgrass, James, 2, Keir-terrace, Maxwell-road, Pollokshields, Glasgow
Feb. 3, 1887		Sohn, Charles, F.I.C., 25, Beverley-road, Anerley
June, 18, 1891		Solomon, Frank Oakley, 68, Fern-avenue, Newcastle-on-Tyne
Dec. 17, 1874		Sonstadt, Edward, Church Field, Cheshunt, Herts
Dec. 18, 1884	Trans.	Sorabji Bomanji, Khan Bahadur, Ph.D., C.E. (Bombay) Assoc., M.I.C.E. (Lond.), 8, Sleater-road, Bombay
June 15, 1893		Sorrell, Henry Thomas, Holly Lodge, Millbrook-road, Southampton
May 6, 1875		Southall, Alfred, Garrick House, Richmond Hill, Edgbaston
June 21, 1883		Soward, Alfred W., 28, Therapia-road, Honor Oak, S.E.
Dec. 15, 1892		Spackman, Charles, Rosehaugh, Clitheroe, Lancashire
Feb. 21, 1889		Speakman, James, Penhold, Post Office, Calgary, Alberta, Canada
Jan. 18, 1866		Speir, James, 70, Parliament Hill-road, N.W., and St. George's House, Eastcheap
Feb. 1, 1883		‖Spencer, Ernest Samuel, Arborfield, Wimbledon Park
April 4, 1878		Spencer, James, B.Sc., 38, Ash-grove, Bradford
Mar. 4, 1886		Spencer, Richard, Woodside, Croslands Park, Barrow-in-Furness
Feb. 6, 1879		‖Spencer, Samuel, 21, St. George's-road, Southwark, S.E.
June 16, 1887		Spencer, W. Shelley, 105, Bridge-street, Farnworth, near Bolton, Lancashire
June 7, 1894		Spenzer, John George, M.D., Ph.D., Prof., Western Reserve University, 370, Central-avenue, Cleveland, Ohio, U.S.A.
Feb. 3, 1859	Trans.	‖Spiller, John, 2, St. Mary's-road, Canonbury, N.
Jan. 15, 1863		‖Spiller, William, Atlas Dye Works, Hackney-wick, E.
June 18, 1885		Spilsbury, James, 4, Lynton-road, Crouch End, London, N.
June 4, 1885		‖Spottiswoode, W. Hugh, Balliol College, Oxford; and 41, Grosvenor-place, S.W.
Feb. 18, 1892		Spray, Henry John, c/o Messrs. Hopkins and Williams, Bridgefields, Wandsworth, S.W.

Date of Election.		
Dec. 1, 1864	Trans.	Sprengel, Hermann Johann Philipp, Ph.D. (Heidelb.) F.R.S., Royal Prussian Professor (titular), Savile Club, 107, Piccadily, W.
May 4, 1882		‖Squire, P. Wyatt, 413, Oxford-street, W.
Feb. 4, 1858	Trans.	Squire, W. Stevens, Ph.D., Clarendon House, St. John's Wood-park, N.W.
Feb. 18, 1892		Squires, Alfred James, 32, Derby-road, Farnworth, Widnes, Lancs.
May 5, 1892		Stables, William Herbert, Rev., B.A., The Green, Runcorn, Cheshire
June 21, 1877		Stacey, Henry George, 300, High Holborn, W.C.
Dec. 18, 1879	Trans.	Stallard, George, M.A., Horton Crescent, Rugby
April 21, 1859	Trans.	‖Stanford, Edward Charles, Glenwood, Dalmuir, Dumbartonshire
Mar. 17, 1887		Stanger, W. Harry, Chemical Laboratory, Broadway, Westminster
Feb. 3, 1887		‖Stansell, Lionell W., Bydews, Holland-road, Maidstone, Kent
Dec. 3, 1885		Staples, Henry J., Spondon, Derby
Dec. 15, 1870		Starey, Arthur J., 18, Ashley-road, Hornsey-rise, N.
Dec. 15, 1870	Trans.	‖Stark, J. Fleming, Bromborough Pool, near Birkenhead
Mar. 16, 1876		Starling, J. H., Crossness, Belvidere, Kent
Nov. 16, 1882	Trans.	Stead, J. E., Redcar, Middlesborough
May 4, 1882		Stebbins, James H., jun., Ph.D., 114, Pearl-street, New York
May 7, 1885		Steel, Robert Elliot, County School, Northampton
June 7, 1894		Steel, Robert W., Wedderburn, Paisley
Dec. 5, 1889		Steel, Sydney, 26, Somerset-street, Portman-square, W.
Dec. 4, 1890		Steel, Thomas, c/o Colonial Sugar Refining Co., Sydney, N.S.W.
Dec. 18, 1884		Steele, Robert, 8, Adelaide-square, Bedford
Jan. 17, 1884		Stenhouse, Thomas, 8, West-street, Rochdale
May 5, 1892	Trans.	Stenhouse, James, Gas Works, New-street, Edinburgh
Dec. 6, 1883		Stephens, C. W., 116, Wednesbury-road, Walsall
April 15, 1880		‖Stephens, Henry Charles, M.R. Inst., Avenue House, Finchley
Feb. 21, 1895		Stephenson, Herbert F., 10, Muschamp-road, E. Dulwich, S.E.
Dec. 3, 1885		Stephenson, Stephen, 98, Kensington, Liverpool
Dec. 3, 1891		Stephenson, Thomas, Bellasis-road, Byculla, Bombay
Dec. 6, 1888	Trans.	Stern, Arthur Landauer, D.Sc., F.I.C., 170, Ashby-road, Burton-on-Trent
Dec. 15, 1881		Steuart, Daniel Rankin, Osborne Cottage, Broxburn, Linlithgowshire
Feb. 18, 1864		Stevenson, Thomas, M.D., Sandhurst Lodge, 45, Gresham-road, Brixton, S.W.
Feb. 6, 1879		Stevenson, William, 95A, Southwark-street, S.E.
June 20, 1872		‖Stewart, Walter, 1, Murrayfield-gardens, Edinburgh
Feb. 21, 1889		Stillman, Thomas B., Steven's Institute of Technology, Hoboken, N.J., U.S.A.
Dec. 15, 1881		Stitt, Charles Alfred, 29, Cluny-gardens, Edinburgh
June 21, 1866		Stock, W. F. K., 5, Dixon-terrace, Darlington

Date of Election.		
Feb. 19, 1891		Stockdale, R., the Grammar School, Leeds
June 18, 1874		‖Stocks, Frederic, Snead's Green House, Droitwich, Worcestershire
Nov. 17, 1887		Stocks, Herbert B., 54, Ferndale-road, Southdown-road, Liverpool
Mar. 5, 1885		Stocks, Joseph M., Ramsbottom Paper Mill Co., Ramsbottom, Lancashire
May 3, 1894		Stoddart, Frederick Wallis, Grafton Lodge, Sneyd Park, Bristol
April 17, 1879	Trans.	‖Stokes, A. W., Vestry Hall, Paddington
Dec. 18, 1873		‖Stone, Edward Daniel, Laboratory, 19, Lever-street, Piccadilly, Manchester
April 17, 1890		Stone, Frederick Richard M., 58, Upper Parliament-street, Liverpool
Dec. 2, 1875		‖Stone, J. Harris, M.A., F.L.S., Barrister-at-Law, 3, Dr. Johnson's-buildings, Temple, E.C.
April 17, 1879		‖Stone, William, M.A. Cantab, F.L.S., Oxford and Cambridge, Garrick, and Union Clubs, and D. 6, The Albany, Piccadilly
May 7, 1891		‖Storey, James Ashburner, B.Sc., Warakamure, Matale, Ceylon
June 19, 1884		Stormouth, Thomas, Athol House, Clarence-road, St. Thomas, Exeter
Feb. 3, 1887		‖Strangman, J. Pim, Sarno, Province of Salerno, Italy
May 7, 1885	Trans.	‖Stuart, Charles M., M.A., St. Dunstan's College, Catford, S.E.
Dec. 7, 1893		Styles, R. Curling, Knockhall, Greenhithe, Kent
Dec. 4, 1890	Trans.	‖Sudborough, J. Joseph, Ph.D., B.Sc., University College, Nottingham
Dec. 5, 1878	Trans.	‖Suguira, Shigetake, care of Tokio Chemical Society, No. 7, Nishikonyacho, Tokio, Japan
Feb. 16, 1888		Sumner, Robert Mason, c/o Messrs. Parke, Davis and Co., Detroit, Michigan, U.S.A.
Feb. 3, 1887		‖Sutherland, D.A., F.I.C., 2, Victoria-mansions, Westminster, S.W.
Feb. 21, 1884		Sutton, C. W., 19, Henley-road, Ipswich
April 19, 1860		Sutton, F., Laboratory, Bank Plain, Norwich
Mar. 4, 1886		‖Sutton, F. Napier, 6, Grosvenor-gardens, Willesden Green
June 3, 1875		Swan, Joseph William, M.A., F.R.S., Lauriston, Bromley, Kent
June 20, 1889		Swan, Robert, M. W., 15, Walmer-crescent, Glasgow
May 3, 1894		‖Swinburne, James, 4, Hatherley-road, Kew
Dec. 5, 1889		Swern, Sidney Augustus, The New Municipal Technical School, Gravesend
Feb. 18, 1892		Sykes, James, 76, Lockwood-road, Huddersfield
Feb. 19, 1891		Sykes, M. Carrington, L.P.H. Lond., L.R.C.P. Lond., M.R.C.S. Eng., L.S.A. Lond., Sykeshurst, Barnsley, Yorks.
May 16, 1889		Sykes, Walter J., M.D., 59, Friend's-road, Croydon
Feb. 19, 1891		Symes, K. Edward, 12, Wilton-avenue, Southampton
June 17, 1880		Symons, Brenton, 11, Parade, Truro, Cornwall

Date of Election.		
Dec. 17, 1874		‖Symons, William Henry, M.D. (Brux.), M.R.C.S. Eng., F.I.C. F.R.M.S., Junior Constitutional Club, Piccadilly, W.
Feb. 17, 1881	Trans.	‖Takamatsu, T., Tokio University, Japan
Feb. 3, 1887	Trans.	Takamine, Jokichi, 2111, N. Jefferson-street, Peoria, Ill., U.S.A.
Feb. 15, 1894		Tanner, Alf. E., Westminster Hospital, S.W.
Feb 19, 1874		Tanner, Henry, Prof., The Wallands, Silver Hill, St. Leonards
Dec. 4, 1890		Tate, Francis Henry, 9, Hackins Hey, Liverpool
June 16, 1881	Trans.	Tate, George, Ph.D., College of Chemistry, Duke-street, Liverpool
Dec. 18, 1884	Trans.	‖Tate, Walter, 43, Norwood-grove, Liverpool
May 15, 1890		Tate, William, Royal College of Science, South Kensington, S.W.
Dec. 5, 1867		Tatlock, Robert R., Novara, Stirling
Dec. 6, 1894		Taylor, Albert, 2, Torkington-street, Edgeley, and the Technical School, Stockport
Dec. 2, 1875		Taylor, Andrew, 11, Lutton-place, Edinburgh
Dec. 7, 1882		Taylor, G. Midgley, 27, Great George-street, Westminster
June 7, 1894		Taylor, Herbert J., 9, Portland-villas, Bath-street, Dewsbury
June 17, 1880		‖Taylor, James, B.Sc., Government Metallurgist, Department of Mines, Sydney, New South Wales
June 18, 1891		Taylor, John, 15, Lucius-street, Torquay
April 19, 1888	Trans.	Taylor, John G., Orielton-terrace, Pembroke
Jan. 15, 1874		Taylor, R. L., 37, Mayfield-road, Whalley Range, Manchester
Dec. 6, 1888		Taylor, William, China Sugar Refining Co., East Point, Hong Kong
April 4, 1878		‖Tcherniac, Joseph, Ph.D., Thalstrasse 1, Freiburg, Briesgau, Germany
April 17, 1879	Trans.	Teed, Frank L., D.Sc., 15, Victoria-street, S.W.
May 1, 1877		Terrill, William, 42, St. George's-terrace, Swansea
May 3, 1894		Terry, Edwin, 374, Brixton-road, S.W.
Feb. 15, 1881		Tervet, Robert, 54, Penshurst-road, South Hackney, E.
June 18, 1891		Tetley, Frederick, 3, Mannville-terrace, Horton-road, Bradford
Feb. 16, 1893		Thackrah, James R., M.A., Ph.D., Technical Schools, Tavistock-road, Plymouth
Dec. 18, 1884		Thom, George, Dollar, N.B., and 48, Stanford-road, Victoria-road, Kensington, W.
Nov. 17, 1859		‖Thomas, Andrew, 13, Hendley-street, Adelaide, South Australia
Dec. 7, 1871		‖Thomas, Charles, Woodcote, Stoke Bishop
Mar. 5, 1874		Thomas, Harry Edgcombe, Rockleaze Point, Clifton, Bristol
Feb. 18, 1875	Trans.	‖Thomas, Joseph William, Drumpellier, Brunswick-road, Gloucester
Feb. 5, 1863		‖Thompson, Beeby, 55, Victoria-road, Northampton
Mar. 4, 1886	Trans.	‖Thompson, Claude M., M.A., University College, Cardiff
June 7, 1894		Thompson, Edward Cumming, 5, Gubyon-avenue, Herne Hill, S.E.
June 15, 1893		Thompson, Frank Ernest, 97, Murdock-road, Handsworth, Birmingham

Date of Election.		
May 5, 1892		Thompson, George-de-Roos, 17, Tanfield-street, Leeds
May 4, 1893		Thompson, George R., The Laboratory, 57, Dock-street, Newport, Mon.
Dec. 16, 1886		Thompson, W. Phillips, 95, Shrewsbury-road, Claughton, Birkenhead
Dec. 17, 1885	Trans.	Thomson, Andrew, D.Sc., 10, Pitcullen-terrace, Perth
Nov. 2, 1876	Trans.	Thomson, George C., 23, Kersland-terrace, Hillhead, Glasgow
April 15, 1858	Trans.	‖Thomson, John, 12, Lower Kennington-lane, S.E.
Jan. 18, 1872	Trans.	Thomson, John Millar, King's College, W.C.; and 85, Addison-road, W.
Jan. 18, 1872		Thomson, William, Royal Institution Laboratory, Manchester
Dec. 3, 1885		Thorne, Edward E. H., care of H. E. Thorne, Esq., Bridgetown, Barbadoes, West Indies
Feb. 16, 1882	Trans.	Thorne, Leonard T., Ph.D., 8, Dynevor-road, Richmond, Surrey
Nov. 20, 1890		Thornley, J., Brooks, jun., c/o Felton, Grimwash, and Co., Jeffcott street, Melbourne, Australia
Dec. 3, 1891		Thorp, Walter, 21, Barrington-street, Limerick
Feb. 1, 1866	Trans.	‖Thorp, William, B.Sc., 24, Crouch Hall-road, Crouch End, London, N.
Feb. 16, 1871	Trans.	†Thorpe, T. E., Ph.D. (Heid.), B.Sc. (Vict.), D.Sc. (Dubl.), LL.D. (Glas.), F.R.S., Inland Revenue, Somerset House, W.C.
Dec. 7, 1893		Thorpe, Joselyn Field, Neuenheimer, Landstrasse 12, Heidelberg
May 7, 1891		Thonger, C. G. Freer, M.R.A.C., Colonial College, Hollesley Bay, Suffolk
Dec. 2, 1875	Trans.	Thresh, J. C., D.Sc., Medical Officer of Health, Chelmsford
June 7, 1894		Thudichum, George Dupré, Montrose, Dorset-road, Merton Park, Wimbledon
Dec. 20, 1880	Trans.	Thudichum, John L. W., M.D., 11, Pembroke-gardens, W.
Dec. 2, 1860		Thwaite, B. H., Moorfields-chambers, 95 and 97, Finsbury-pavement, E.C.
Feb. 19, 1863	Trans.	Tichborne, C. R. C., Ph.D., 15, North Great George-street, Dublin
Mar. 17, 1881	Trans.	Tiemann, Ferdinand, Prof., Dr., Bendlenstrasse 18, Berlin, W.
June 1, 1865	Trans.	Tilden, William A., Prof., F.R.S., 9, Ladbroke-gardens, W.
Dec. 5, 1889	Trans.	‖Tingle, J. Bishop, Ph.D., Gordon's College, Aberdeen
May 7, 1891		Tocher, James Fowler, A.I.C., 1, Chapel-street, Peterhead
June 20, 1853		‖Tomlin, Andrew, Valparaiso
June 2, 1864	Trans.	Tomlinson, Charles, F.R.S., 7, North-road, Highgate, N.
Feb. 21, 1884	Trans.	‖Tompson, Frederick William, 1, St. Mildred's-road, Ramsgate
June 21, 1877		‖Toms, Frederick Woodland, F.I.C., States Analyst, Jersey
Jan. 15, 1855		‖Tookey, Charles, Museum of Practical Geology, Jermyn-street, S.W.
Dec. 3, 1868	Trans.	Tosh, Edmund G., The Lund, Ulverston, Lancashire

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† Longstaff Medallist, 1881.

Date of Election.		
Feb. 16, 1893		||Towers, John William, Victoria-road, Widnes
Feb. 2, 1883		Townsend, Charles F., 31, Elms-road, Clapham Common, S.W.
June 6, 1887		Traphagen, Dr. Frank W. Bozeman, Montana, U.S.A.
Feb. 18, 1892	Trans.	Travers, Morris W., 2, Phillimore-gardens, Kensington, W.
Feb. 15, 1894		Trench, George, Cotton Powder Co., Faversham
Mar. 15, 1888		||Trewby, Herbert, Radnor House, Ribblesdale-road, Hornsey, N.
June 16, 1881		Trigger, Oliver, Chemical Dept., Royal Arsenal, Woolwich
Dec. 4, 1873	Trans.	||Truman, Edgar Becket, M.D. (St. And.), F.I.C., 31, Derby-road, Nottingham
Dec. 5, 1889		Tucker, Willis G., M.D., Albany, New York, U.S.A.
May 5, 1892		Tuer, Arthur Holt, Thornhill, Wigan, Lancashire
Dec. 2, 1886		Turner, Arthur, L.D.S. Ed., The Limes, Aylesbury
Dec. 6, 1888	Trans.	Turner, Charles, 225A, Oxford-street, Manchester
Feb. 1, 1883	Trans.	||Turner, Thomas, County Offices, Stafford
Feb. 21, 1889	Trans.	Turpin, George Sherbrooke, M.A. (Cantab), D.Sc. (Lond.), The Technical School, Huddersfield
Dec. 15, 1892		Turton, Albert Henry, F.R.G.S., Ashleigh, Carlyle-road, Edgbaston, Birmingham, and Launceston, Tasmania
Feb. 2, 1871		||Tustin, John Robt., The Elms, Merton Hall-road, Wimbledon, S.W.
Feb. 2, 1888	Trans.	Tutton, Alfred E., Royal College of Science, South Kensington
June 19, 1879		Tweedie, George R., 3, Granville-terrace, East Cliff, Ramsgate
May 5, 1892		Tweedie, Thomas Shortridge, The Moat, Annan
Feb. 17, 1876		Typke, P. G. W., Ravenhurst, New Malden
Dec. 7, 1876		Tyrer, Thomas, Stirling Chemical Works, Abbey-lane, Stratford
Dec 3, 1885		Tyson, Thomas B., 1, New China Bazaar-street, Calcutta
April 6, 1876		||Udall, Thomas Bertram, Newcastle-under-Lyme, Staffordshire
Nov. 16, 1865		Umney, Charles, 50, Southwark-street, S.E.
Feb. 16, 1893	Trans.	Umney, John C., 50, Southwark street, London, S.E.
Feb. 21, 1889		Underhill, Thomas J., 6, The Terrace, Royal Victoria Yard, Deptford, S.E.
June 3, 1869		||Vacher, Arthur,
Mar. 16, 1882		||Vacher, Francis, Birkenhead
Mar. 6, 1890		Valentin, Basil William, Messrs. Buckley Bros., Brewery, Llanelly, S. Wales
Dec. 1, 1887		||Vargas, Vergara J. M., Laboratorio Central, Calle 13, No. 206, Bogota, Republic of Columbia, South America
Mar. 1, 1883		Vasey, S. A., Kingsthorpe, Lower Park, Loughton, Essex
Dec. 7, 1882		Vasey, Thomas E., 6, South-parade, Leeds, and P.O., Box 1149, Montreal, Canada
June 15, 1893		Vautin, Claude T. J., 42, Old Broad-street, E.C., and 3, Upper Hamilton-terrace, N.W.

Date of Election		
Dec. 6, 1894		Vaux, Cuthbert, 11, Thornhill-park, Sunderland
April 17, 1879	Trans.	Veley, Victor H., M.A., F.R.S., 22, Norham-road, and University Museum, Oxford
Feb. 19, 1891		Velling, F. W. De, B.A., Upper Board Schools, Heckmondwike
May 6, 1881		Venable, Frank P., Ph.D., Chapel Hill, North Carolina
Jan. 18, 1872		Vincent, Charles W., F.R.S.E., F.C.S. of Berlin, Reform Club, Pall Mall, S.W., and Royal Institution, W.
May 16, 1889		Virtue, William, Abbey-street and Waterside Distilleries and Mills, Londonderry
Feb. 21, 1884		‖Voelcker, Edward William, Essex Villas, Kensington, W.
Jan. 17, 1884		‖Voelcker, John A., Ph.D., 20, Upper Phillimore gardens, Kensington, W.
April 17, 1862		Von Bose, C. Moritz, Messrs. Gehe and Co., Chemical Works, Dresden
April 4, 1889		‖Voss, Walter Arthur, 159, Croydon-road, Anerley, S.E.
Nov. 19, 1885		Vulte, Hermann T., Ph.B., School of Mines, Columbia College, East 49th-street, corner of 4th-avenue, New York
Feb. 6, 1890		Wade, John, B.Sc. (Lond.), 15, St. George's Mansions, Bloomsbury, W.C., and Guy's Hospital, S.E.
Dec. 6, 1894		Wagner, W. G., 101, Leadenhall-street, E.C.
April 17, 1884		Wainwright, Howard, Ph.D., 22, West 46th Street, New York, City, U.S.A.
Feb. 16, 1893		Wait, Chas. E., Prof., University of Tennessee, Knoxville, U.S., N.A.
May 17, 1888		Wait, Frank Goodell, Geological Survey Department, Ottawa
Dec. 7, 1893		Walden, William Herbert, 35, Clapham-road, S.W.
Feb. 15, 1866	Trans.	Walenn, W. H., 9, Carleton-road, Tufnell Park, N.
Feb. 16, 1893		Walke, Willoughby, 1st Lieut., Fort Monroe, Virginia, U.S., N.A.
Jan. 16, 1868		Walker, Maj.-Gen. Alexander, C.S.I., Director-General of Ordnance, Race View, Simla, India
Mar. 17, 1881		‖Walker, Archibald, B.A., 8, Crown-terrace, Dowanhill, Glasgow
June 7, 1894		Walker, Chas. H. H., B.A., 13, Hyde-road, Eastbourne
Dec. 5, 1889		Walker, Daniel, A.K.C., B.Sc., School of Mines, Ballarat, Victoria
Feb. 6, 1890	Trans	‖Walker, James, Prof., D.Sc., 8, Windsor-terrace, Dundee
Feb. 2, 1865	Trans.	Walker, J. F., M.A., 45, Bootham, Yorks; and Sidney College, Cambridge
April 17, 1890		Walker, James S. H., M.B., C.M., Earlybank, Perth
Dec. 6, 1888		Walker, J. T. Ainslie, The Laboratory, Rishton Paper Mills, near Blackburn, Lancashire
Feb. 17, 1881		Walker, Robert William, Bank Cottage, Edgworth, near Bolton
April 17, 1879		‖Walker, Thomas Hatfield, 1, Picton-place, Newcastle-on-Tyne
June 4, 1884		‖Wallace, Prof. Robert, The University, Edinburgh

Date of Election.		
Dec. 5, 1878	Trans.	‖Waller, Elwyn, Ph.D., School of Mines, Columbia College, corn 49th-street, 4th-avenue, New York
Mar. 3, 1887		Wallis, Henry Weston
Mar. 1, 1883		‖Walmsley, R. Mullineux, D.Sc., Heriot-Watt College, Edinburgh
Dec. 6, 1888		Walrond, Edward Dalrymple, B.A., North Eastern Counties School, Barnard Castle, Durham
Mar. 20, 1884		‖Walton, Thomas Ulrick, B.Sc., F.I.C., Colonial Sugar Refinery Co., Sydney, New South Wales
April 21, 1864		Ward, George, Buckingham-terrace, Headingley, Leeds
Dec. 3, 1891		Ward. Thomas Armistead,
April 20, 1871		Ward, William, Sheffield Moor, Sheffield
Dec. 4, 1873	Trans.	Warden, C. J. H., Prof. of Chemistry, Medical College, Calcutta
May 20, 1875		Wardle, Thomas, F.G.S., Leek, Staffordshire
Mar. 19, 1863	Trans.	‖Warington, Robert, F.R.S., Harpenden, St. Alban
Feb. 21, 1895		Warington, T. C., 1, Charles-street, Hanley, Staffs.
June 15, 1893		Warmington, Edward A., Ph.D., F.I.C., 36, Cannon-st., Birmingham
Dec. 7, 1871	Trans.	Warner, George Joseph, 41, Albert-road, Widnes
May 5, 1891		Warren, Cyprian A., Messrs. Watney's Brewery, Richmond
Dec. 6, 1894		Warren, W. L., 12, Westland-row, Dublin
Dec. 6, 1888		Warrick, Frederic Walmsley, 59, Great Ormond-street, W.C.
Nov. 17, 1887	Trans.	Warrington, Arthur Walley, University Coll. of Wales, Aberystwith
Nov. 16, 1882		Waterfall, Charles J., Marienberg, Somerville-road, Bristol
June 7, 1894		Waterfield, A. Swainson, Westwood-road, Beverley, York
Dec. 6, 1894		Waterhouse, Robert, 101, Leadenhall-street, E.C.
April 4, 1889		Waterhouse, Wm. John, B.Sc., Christ Church, Oxford
Mar. 15, 1888		Wates, Edward Arthur, Secunderabad, Deccan, India
May 4, 1893		Watson, A. Forbes, Chemistry Dept., University of Edinburgh
Mar. 5, 1885		Watson, Charles, Walsden Chemical Works, near Todmorden
Jan. 18, 1872		Watson, David, D.Sc., The Broughton Copper Works, Salford, Manchester, and Willow Bank House, Kersal Dale, Higher Broughton
June 16, 1887		‖Watson, Frederick Percy, 6 and 7, Bailgate, Lincoln
May 4, 1882		Watson, George, 16, East Nelson-street, Whitevale, Glasgow
Mar. 1, 1883		‖Watson, Thomas Donald, 16, St. Mary's-road, Bayswater, W.
Jan. 20, 1876	Trans.	‖Watson, W. H., Braystones, near Whitehaven, Cumberland
June 21, 1877		Watt, Alexander, c/o Messrs. Macfie and Sons, 34, Moorfields, Liverpool
Mar. 1, 1883	Trans.	Watts, Francis, Govt. Laboratory, St. John's, Antigua, W. Indies
Feb. 1, 1872	Trans.	‖Watts, John, D.Sc., Chemical Laboratory, Museum, Oxford
Dec. 5, 1878	Trans.	Watts, John I., Fairleigh, Hartford, Cheshire
Dec. 6, 1888		Way, Edward J., F.I.C., Eastleigh Syndicate, Box 84, Keerksdorp, Transvaal, South African Republic
June 6, 1872		Weaver, Richard, C.E., The Sanitary Laboratory, Manor-street, Clapham, S.W.

Date of Election.		
Mar. 1, 1883	Trans.	Webster, Charles Stuart, Malvern House, Redland, Bristol
Mar. 1, 1866		Webster, G. W., 33, Bridge-street-row, Chester
June 21, 1877		Webster, William, Glencot, Blackheath Park, Blackheath, S.E
April 4, 1889		Weir, P. A., Surgeon-Major, M.B., Agency Surgeon, Beloochistan *viâ* Quetta
Feb. 16, 1888		Welch, J. Cuthbert, Messrs. Simonds, The Brewery, Reading
Dec. 7, 1893		Welchman, Frank Ernest, 16, Carlton road, Putney Hill, S.W.
Feb. 19, 1891		Wellington, Stephen N., M.I.C.E., The Bungalow, The Gas Works, Parel, Bombay
May 5, 1892		Wells, George I. J., F.I.C., 47, Parkgate-road, Chester
June 19, 1884	Trans.	Wells, James S. C., Ph.D., Hackensack, New Jersey, U.S.A.
Feb. 6, 1890		Wells, S. Russell, B.Sc., M.B., 14, Girdlers-rd., West Kensington
Feb. 18, 1888	Trans.	Werner, Emil A., 5, Church-avenue, Rathmines, Dublin
Dec. 15, 1892		Westaway, Frederick William, B A., Higher Grade School, St. George's, Bristol
Dec. 17, 1874	Trans.	Wethered, Edward, 4, St. Margaret's-terrace, Cheltenham
Dec. 6, 1883		Wetzel, Henry A., Messrs. Parke, Davies & Co., Box 470, Detroit, Michigan, U.S.A.
Mar. 4, 1886		Wertheimer, Julius, Prof., B.Sc., B.A., F.I.C., Merchant Venturers' Technical College, Bristol
May 5, 1892		Whalley, Lawrence J. de Lancaster, 26, Park-place, Greenwich, S.E.
June 15, 1893		Whalley, Sydney, 38, Havelock-street, Canterbury
Feb. 16, 1893		‖Wheeler, William Ernest, Cumberland-house, Meynell-road, South Hackney, N.E.
Dec. 6, 1888		Whieldon, Ernest William, 12, Bedford-road, Tottenham, N.
April 17, 1879		Whitaker, Thorp, Messrs. Ripley & Sons', Dye Works, Bradford, Yorkshire
Feb. 16, 1893		White, H. C., Prof., Athens, Georgia, U.S.A.
Dec. 3, 1891		White, Henry, 43, Woodstock-road, Sheffield
Mar. 20, 1862		White, Leedham, 2, Lime-street-square, E C.
April 4, 1889		‖White, John Tsawoo, M.A , F.I.C., Treasury Office, Katha, Upper Burmah
Dec. 7, 1893		White, William Gilchrist, Lamb Roe, Whalley, near Blackburn
Feb. 5, 1885		Whitehead, Henry H., The Royal Brewery, Brentford
Dec. 5, 1889		Whitehouse, William, Albany House, Bradmore, Wolverhampton
Dec. 15, 1892		Whiteside, John Lowe, 51, Cannon-street, Bolton
June 16, 1892		Whiteley, Fred., B.A., 20, Dunkerley-street, Oldham
April 15, 1886	Proc.	Whiteley, R. Lloyd, University College, Nottingham
Nov. 5, 1863		Whitfield, John, 113, Westborough, Scarborough
June 15, 1893		Whittaker, Thomas, 76, Arden-terrace, Accrington
Dec. 5, 1889		Whittam, Matthew, M.A., The Isle of Wight College, Ryde
Dec. 5, 1889		Wigan, Basil P., North Cheshire Brewery Company, Macclesfield, and 43, Christ Church-square, Macclesfield

Date of Election.		
Dec. 15, 1892		Wigham, F. H., Cherrygarth, Eastmoor-road, Wakefield
May 7, 1891		Wild, John, 28, Hyde-road, Woodley, Stockport
Feb. 19, 1891		Wilkinson, David,
May 4, 1893		Wilkinson, John, Drighlington, near Bradford
Dec. 17, 1885		Will, Wm. Watson, 1, St. Agnes-place, Kennington Park, S.E.
Feb. 19, 1891		Will, W., Ph.D., Beethhoven-strasse, No. 1, Berlin, N.W.
Jan. 16, 1862	Trans	‖Williams, C. Greville, F.R.S., F.I.C., Castlemaine, Oakhill-road, Putney, S.W.
Dec. 15, 1892		Williams, John, Government Laboratory, British Guiana
June 21, 1883	Proc.	Williams, Rowland, Sunny Lea, Aldcliffe-road, Lancaster
June 18, 1891		Williams, Seward W., c/o Seabury and Johnson, 8, Brighton-avenue, East Orange, New Jersey, U.S.A.
Dec. 5, 1872		‖Williams, Thomas, Chemical Laboratory and Assay Office, A, Queen Insurance-building, 10, Dale-street, Liverpool
Mar. 5, 1885		Williams, Walter Collingwood, B.Sc., 68, Grove-street, Liverpool
Feb. 19, 1874	Trans	‖Williams, W. Carleton, Firth College, Sheffield
Dec. 15, 1892		Williams, William, County Offices, Westgate-street, Cardiff, and 63, Plymouth-road, Penarth
Feb. 7, 1878		Williams, W. J., 635, Market-street, Camden, N.J., U.S.A.
Feb. 15, 1894		Williams, W. Lloyd, 10, Miskin-road, Dartford, Kent
May 15, 1848	Trans	‖Williamson, A. W., LL.D., F.R.S., High Pitfold, Haslemere
Dec. 4, 1874	Trans.	‖Williamson, Robert, Low Walker, Newcastle-on-Tyne
Mar. 4, 1886	Trans	Williamson, Sidney, Chem. Laby., United Colleges, St. Andrews
June 15, 1871		Willmore, Charles. Queenwood College, near Stockbridge, Hants
Dec. 5, 1872		Wills, Jos. Lainson, c/o Drs. Wyatt and Saarbach, 12, Old Slip, New York
Dec. 2. 1875		Wills, Samuel Day, 11, Upper Belgrave-road, Clifton, Bristol
Dec. 5, 1889		Wilkie, John, M.D., 20, Buckingham-street, Strand, W.C.
Dec. 5, 1892		Wilsmore, N. Y. M., 31, Stanley-gardens, Hampstead, N.W.
Feb. 5, 1885	Trans.	Wilson, A. C., Borough Hall, Stockton-on-Tees
June 19, 1879		‖Wilson, Charles J., 14, Old Queen-street, Westminster
Dec. 6, 1894		Wilson, Christopher, The Grammar School, Manchester
June 21, 1883	Trans.	‖Wilson, David, jun., Carbeth, Killearn, by Glasgow
Nov. 19, 1855		Wilson, G. F., F.R.S., Heatherbank, Weybridge Heath
Dec. 18, 1879		Wilson, J. Millar, Norwich, Conn., U.S.A.
April 1, 1875		‖Wilson, James, M.A., Barrister-at-law, 2, Essex-court, Temple, and 23, Aberdeen-road, Highbury, N.
May 16, 1878		Wilson, James Henry, 6, Fenchurch-buildings, E.C.
Dec. 3, 1891		Wilson, John Henry, A.I.C., 29, Radford-street, Coventry
Nov. 20, 1890		Wilson, J. Mitchell, M.D., Medical Officer of Health, Doncaster
Dec. 6, 1894		Wilson, R. H., 59, Harder's-road, Peckham, and Washing Stocks Farm, Bromsgrove
Dec. 7, 1871		Wilson, William John, 6, Malden-road, Watford
Dec. 17, 1885		Wilson, William M., 63, Queen's-square, Bristol

Date of Election.		
Dec. 5, 1889		Wiltshire, J., Shire Hall, Hereford
Feb. 5, 1874		Wiltshire, Thomas Pemberton, c/o New York Tartar Company, 9th-street and Gowan's Canal, Brooklyn, New York
Dec. 18, 1884		Wilton, Thomas, The Gas Light and Coke Co., Beckton, North Woolwich
Dec. 1, 1887		Winder, Bartlett W., Sunny Bank House, 43, Broomhall-place, Sheffield
Dec. 7, 1893		Winder, Edward Humphreys, 37, Vincent-square, London, S.W.
Feb. 15, 1894		Wingate, Hamilton M., B.Sc., c/o MacCullock and Ekber, Works, Cassilis, Gippsland, Victoria
Mar. 16, 1876		Winser, Percy James, Greendale, Bebington, near Birkenhead
Nov. 19, 1885		‖Winstone, Arthur B., 7, Gray's-inn-square, W.C.
Mar. 2, 1857		Winstone, Benjamin, M.D., 100, Shoe-lane, E.C., and 58, Russell-square, W.C.
Dec. 3, 1891		Winterton, A. W., 6, Linden-terrace, Rotherham
June 15, 1876	Trans.	Witt, Otto N., Ph.D., 33, Lindenallée, Westend, Charlottenburg, near Berlin
Dec. 5, 1867		Wood, Augustus A., 74, Cheapside, E.C.
April 4, 1889		Wood, Charles, 5, Wood-view, Bradford, Yorks
Jan. 19, 1860	Trans.	‖Wood, Charles Henry, Bellevue, Rusham-road, Egham
Dec. 7, 1876		Wood, John, Portland-villa, Troon, N.B.
Dec. 4, 1890		Wood, Sidney, B.Sc., S. Kensington Museum, S.W.
Dec. 18, 1884		Wood, William H., B.A. (Oxon.), La Martinière, Calcutta
Feb. 19, 1880		Wood, W. H., 3, New-road, Halifax
Dec. 7, 1871	Trans.	Woodcock, Reginald C., The American and Continental Sanitation Company, 636 to 642, West 55th-street, New York
Feb. 18, 1892		Woods, Hugh, 11, Archway-road, Highgate, London, N.
April 19, 1888		Woodward, James, B.Sc., B.A., F.I.C., 144, Osborne-road, Forest Gate, E.
April 4, 1889		Woolf, Mortimor, 16, Greville-place, N.W.
Dec. 6, 1889		Woosnam, Richard W., 36, Oaklands-road, Cricklewood, N.W.
Nov. 19, 1885		Wormley, Theodore G., M.D., University of Pennsylvania, Department of Medicine, Philadelphia
Dec. 18, 1884		Worrall, J. Hall, F.I.C., Howsley, Chapeltown, near Sheffield
Feb. 4, 1858	Trans.	‖Worsley, Philip J., Rodney Lodge, Clifton, Bristol
Feb. 21, 1878	Trans.	Wright, Lewis Thompson, 1, Victoria-street, Westminster, S.W.
June 7, 1894		Wright, Robert, 11, Eagle-parade, Buxton
Mar. 4, 1886		Wright, William T., 8, Grange-crescent, Sheffield
Feb. 4, 1864		Wrightson, John, Charford House, Salisbury
Feb. 19, 1891		Wyatt, Thomas M., Chemical Department, Royal Arsenal, Woolwich, S.E.
Dec. 2, 1880		Wyborn, John Middleton, 26, Widmore-road, Bromley, Kent

Date of Election.		
Nov. 20, 1884		‖Wyley, W. Fitzthomas, Wheatly-street, Coventry
May 7, 1885	Trans	Wynne, W. P., D.Sc., Royal College of Science, South Kensington, and 35, Parson's-green, Fulham, S.W.
June 4, 1874		Yates, Robert, 64, Park-street, Southwark
Dec. 16, 1886		Yoshida, H., Science College, Imperial University, Tokyo, Japan
Feb. 5, 1885		Young, Alfred C., 64, Tyrwhitt road, St. John's, S.E.
Mar. 4, 1886		‖Young, Brougham,
Mar. 15, 1877		Young, Frank W., High School. Dundee, and Woodmuir, West Newport, Fife, N.B.
Dec. 4, 1890		‖Young, George, Ph.D., Firth College, Sheffield
Feb. 21, 1895		Young, H. Stow, 13, Balham-grove, S.W.
June 21, 1877		Young, J. Rymer, 42, Sankey-street, Warrington
Feb. 5, 1874		Young, John, 164, Bath-street, Glasgow
June 16, 1887	Trans.	Young, John William, B.Sc., B.A., Analyst's Office, Great Northern Railway Plant, Doncaster, and 25, Hall Gate, Doncaster
Feb. 16, 1882	Trans.	‖Young, Sydney, D.Sc., F.R.S., University College, Bristol, and 13, Aberdeen-terrace, White Ladies'-road, Bristol
Dec. 16, 1894		Young, James, 4, Plumstead Common-road, Woolwich
Nov. 6, 1873		‖Young, W. C., Normanhurst, High-road, Romford, Essex
April 4, 1878		Zingler, Maximilian, 19, Buckland crescent, Belsize Park, N.W., and 16, Fenchurch-street, E.C.

FOREIGN MEMBERS.

NUMBER NOT TO EXCEED FORTY.

Date of Election.	
May 18, 1876	Baeyer, Adolph von, F.R.S., University of Munich
Feb. 1, 1883	Beilstein, Prof. F., Ph.D., Technological Institute, St. Petersburg
Mar. 1 1860	Berthelot, M., F.R.S., Collège de France, Paris
Feb. 2, 1888	Boisbaudran, Lecoq de, 36, Rue Prony, Paris
Feb. 1, 1842	Bunsen, R. W., Ph.D., F.R.S., University of Heidelberg
June 19, 1862	*Cannizzaro, S., Senato di Roma
Feb. 1, 1883	Cleve, Prof. P. T., Ph.D., University, Upsala, Sweden
Feb. 1, 1883	Erlenmeyer, Prof. E., Ph.D., Frankfurt-on-Main
June 16, 1892	Fischer, Emil, Ph.D., University of Berlin
Feb. 1, 1883	Fittig, Prof. R., Ph.D., University, Strassburg
Nov. 4, 1844	Fresenius, C. Remigius, Ph.D., Wiesbaden
May 18, 1876	Friedel, C., École des Mines, Paris
May 3, 1866	Gibbs, Prof. Wolcott, Cambridge, Massachusetts, U.S.
June 16, 1892	Graebe, Carl, Ph.D., University of Geneva
Feb. 2, 1888	Hoff, Prof. J. H. van't, Ph.D., 103, Stadtonderskade, Amsterdam
June 19, 1862	Kekulé, Prof. A., F.R.S., University of Bonn
Feb. 2, 1888	Ladenburg, Prof. A., Ph.D., Kaiser Wilhelmstrasse, 43, Breslau
Feb. 2, 1888	Landolt, Prof. H., Ph.D., Königgratzerstrasse, 123B, Berlin, W.
June 16, 1892	Lieben, Adolph, Ph.D., University of Vienna
Feb. 1, 1883	†Mendeléef, Prof. D., Ph.D., University, St. Petersburg

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* Faraday Lecturer, 1872.

† Faraday Lecturer, 1889.

Date of Election.	
Feb. 1, 1883	Meyer, Prof. Victor, Ph.D., University of Heidelberg
Feb. 2, 1888	Nilson, Prof. L. F., Ph.D., Albano, Stockholm
June 19, 1862	Pasteur, L., F.R.S., L'Institut Pasteur, Paris
Mar. 1, 1860	Peligot, E., à la Monnaie, Paris
May 3, 1866	Rammelsberg, Prof. C. F., Berlin
June 16, 1892	Schiff, Hugo, Ph. D., University of Florence
June 16, 1892	Schlœsing, Th., Ph.D., Institut Agronomique, Paris
May 18, 1876	Thomsen, Prof. Julius, Ph.D., University of Copenhagen
Feb. 2, 1888	Wislicenus, Prof. Johannes, Ph.D., University, Leipzig

FARADAY LECTURERS.

1869. J. B. A. Dumas.
1872. S. Cannizzaro.
1875. A. W. von Hofmann.
1879. A. Wurtz.
1881. H. von Helmholtz.
1889. D. Mendeléef.
1895. Lord Rayleigh.

LONGSTAFF MEDALLISTS

1881. T. E. Thorpe, F.R.S.
1884. C. O'Sullivan, F.R.S.
1888. W. H. Perkin, F.R.S.
1891. F. R. Japp, F.R.S.
1894. H. T. Brown, F.R.S.

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